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CONTENTS.

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ON THE ACTION OF THE COMPOUNDS OF CHLORINE BROMINE AND IODINE WHEN INTRODUCED DIRECTLY INTO THE BLOOD. By JAMES BLAKE, M.D., F.R.C.S., *San Francisco, California.*

THE following experiments were performed to ascertain the physiological action of the compounds of this well marked group of elements. The importance of the chlorides in certain physiological processes, and the value of the compounds of Iodine and Bromine as remedies when these processes are carried on abnormally, would invest with interest any investigations undertaken with a view to arrive at a knowledge of their action on the living tissues and solids. The fact that these elements all form distinct acid compounds both with oxygen and hydrogen points them out also as peculiarly fitted for shewing the differences caused by the introduction of the simplest change in the composition of a substance on its physiological action.

The experiments were performed on dogs; the acid diluted with water was introduced directly into the blood, either through the jugular vein or the axillary artery, the hæmadynamometer being generally used to detect the effects produced on the circulation either as they influenced the action of the heart or the passage of the blood through the systemic or pulmonary capillaries.

Experiment 1. *Hydriodic Acid.*—Into the *jugular vein* of a large healthy dog, weighing 18lbs., was introduced a tube with which to connect the syringe. Into the femoral artery was introduced another tube with which to connect the hæmadynamometer. Pressure before the injection 4·5 to 5·5 inches (mercurial). Fifteen drops of hydriodic acid, sp. gr. 1·12, in ℥ss. of warm water, were injected into the jugular vein. The animal did not appear to suffer any effect on respiration or on the circulation. After an interval of five minutes 24 drops of the acid in the same quantity of water were injected into the vein. No immediate effect was produced; but after two minutes the heart's action was observed to be more irregular; or the tonicity of the arteries was altered, as the mercury oscillated between 3·5 and 6 inches. The respiration was also rather deeper. After five minutes (pressure 4 to 6 inches) ʒij. of the acid, mixed with ℥ss. of water, was injected into the vein: 5″ after the injection the pressure in the arteries had fallen to zero, owing to the arteries receiving no blood, respiration continued, but quicker; 12″ after the injection the pressure in the arteries began to rise; and at 35″ it was up to 5·5 to 7 inches. The breathing now became very rapid. At 5′ the pressure had fallen to 3·5, heart's action slower but regular. Two drachms of the acid were again injected. In 8″ the pressure in the arteries had fallen to zero, no blood reentering the arteries although the heart could still be felt beating. The respiratory movements continued without interruption for three minutes after the circulation had stopped. They then gradually ceased, but a full inspiratory movement was made 4′½ after the arrest of the circulation, and after the thorax had been opened. The eye closed on touching the conjunctiva 2′ after the arrest of the circulation. When the thorax was opened, the right cavities were found distended with blood, so that they could not contract. The left auricle and ventricle were contracting rhythmically. They contained about ʒss. of bright scarlet blood. The blood in the right cavities was dark and grumous; when it was let out the ventricle contracted for some time, but the auricle was motionless and did not contract when irritated; lungs red; frothy secretion in bronchial tubes.

EXPERIMENT 2. *Injection of Hydriodic Acid into the arteries.*—A tube was inserted into the left axillary artery of a strong healthy dog, weighing 18 lbs., the point looking towards the heart, so that the injection should become mixed with the blood in the aorta and immediately circulate through the body. Another tube for pressure was inserted into the femoral. Pressure 4 to 6 inches; ʒj. of the same acid as used in the last experiment was injected into the axillary artery. The immediate effect of the injection was to produce a general tonic spasm, by which respiratory movements were arrested and the animal lay quite rigid. The pressure in the arterial system was at the same time suddenly increased, so that at 5″ after the injection it was 9 to 10 inches, the heart beating regularly. The spasm continued for two and a half minutes, the animal remaining quite rigid, without the slightest respiratory movement. It then relaxed, and there were three or four respiratory movements, after which the animal remained quite still for a minute, when there was another slight respiratory movement, which was the last. During the whole of this time the action of the heart continued regular, and the pressure in the arteries remained at about nine inches, the oscillations being about one inch. Neither the heart's action nor the pressure in the arteries seemed at all influenced by these respiratory movements; in fact it was evident that the presence of the hydriodic acid in the blood rendered the heart independent of oxygenated blood. The eye retained its reflex sensibility during the whole of this time and for 45″ after the last respiratory movement. The animal lay perfectly still for another minute when there was a slight spasm, but no attempt at respiration. The pressure in the arteries now commenced falling; at 5′ after the injection it was down to 6 inches: at 8′ it was at 4 inches, the action of the heart regular. There was at this time a slight muscular tremor. At 9′ the pressure had fallen to 3 inches, the action of the heart slower but regular. A sudden increase in the pressure to 6 inches now took place, although the animal was apparently dead, respiration having been arrested for five minutes. The pressure in the arteries now fell rapidly; at 10′ it was at 3 inches, and at 11′ after the injection the circulation appeared to be arrested. On opening the thorax the cavities on both sides were found

full of dark blood, the right auricle contracting rhythmically; right ventricle slightly; left auricle still; left ventricle contracting slightly but rhythmically. On letting the blood out of the cavities the ventricles continued contracting for some minutes after the auricles were still, and even after they were insensible to mechanical stimuli. The right ventricle contracted 23 minutes after respiration had ceased and 10 minutes after any contraction of the auricle.

Exp. 3. *Injection of Chloric Acid into the arteries.*—Dog weighing 15lbs. Tubes inserted as in the last experiment; pressure 7 to 8 inches: 15 drops of a concentrated solution of chloric acid in ℥ iij. of water were injected into the axillary artery. The pressure immediately rose: in 8″ it was at 12in. Respiration was arrested in 10″. The action of the heart continued regular, oscillation 1 in.; at 2′ the pressure was 9in., at 3′ 30″ 7in.; at 4′ it rose to 9in., although the animal lay to all appearance dead (no movement since the first arrest of the respiration); at 6′ 30″ pressure at 5in., heart beating regularly; at 7′ it rose to 6½in. This was accompanied by a slight movement of the tail and collapse of the parietes of the thorax by which some air was expelled from the lungs. The pressure now gradually diminished: at 10′ after the injection it was at 2in.; and the circulation then seemed suspended. On opening the thorax the ventricles were found contracting rhythmically; auricles still; both cavities contained dark blood; lungs natural.

Exp. 4. *Injection of Bromic Acid into the arteries.*—The tubes were arranged as in the previous experiment. A solution containing 2½ grains of the acid in ℥ iij. of water was injected into the axillary artery. The pressure before the injection was 5 to 6 in. There was expression of pain and violent struggles so that the immediate effect on the pressure could not be observed: 3′ after the injection it was 6 to 8 in.: 5 grs. of the acid in the same quantity of water were injected. The immediate effect seemed to be a slight diminution of the arterial pressure; but in 30″ the pressure increased, and at 1′ 30″ it was 9 to 12 in.; at 3′ it was 7 to 9 in.; at 3′ 30″ there was an increase in the pressure to 8 to 10 in.; at 4′ 30″ pressure 6 to 7 in. After

this it gradually fell; but the contractions of the heart were indicated by the oscillations of the mercury until 12′ after the last injection and for 10′ 30″ after respiration had finally ceased. The respiratory movements were arrested 8″ after the introduction of the injection. They recommenced after 20″; but finally ceased in 1′ 30″. There were partial muscular movements at 3′ 30″ when the increase in the arterial pressure took place; but these were so slight and partial that they could have had no influence on the pressure by contraction of the abdominal or thoracic cavities. On opening the thorax immediately after the apparent arrest of the circulation the ventricles were found contracting; the auricles were still: dark blood in both cavities. On letting out the blood the auricles were unirritable to mechanical stimuli. The lungs were red and slightly crepitant.

Such are the facts that are observed after the injection of any of the oxygen or hydrogen compounds of Iodine Chlorine or Bromine into the veins or arteries. As experiments performed with Chloric and Hydrochloric, Bromic and Hydrobromic acids show that these compounds produce exactly analogous effects, they so far carry out the law I have before (Vol. III. of this *Journal*, p. 24), alluded to, of the analogous action of isomorphous substances. The most striking phenomena are the contraction of the blood-vessels both systemic and pulmonary; in one instance arresting the passage of the blood through the lungs, rapidly leading to changes in their texture and effusion into the bronchial tubes, and in the systemic arteries augmenting the pressure to 10 to 12 inches. Besides these more marked effects, are the arrest or suspension of the respiratory movements for 3 or 4 minutes and their again commencing, after unoxygenated blood had been circulating for this time through the nervous centres; the continuance of the irritability of the heart 9 minutes after respiration had ceased, shown not only by slight peristaltic movements, but by regular rhythmical contractions strong enough to continue the circulation under almost the normal pressure. The continuance of the irritability of the ventricles longer than that of the auricles is also a curious phenomenon, and has been observed in every experiment where these substances have been injected directly into the arteries. The increase of pressure that takes place in the

arteries, some minutes after every other organ except the heart had been apparently dead, and without any renewed respiration, is also an interesting physiological fact. I am of opinion, however, that most of these facts can be referred to the action of these substances on the capillary circulation. When injected into the veins, the cause of death is evidently due to the arrest of the passage of the blood through the lungs, or, in cases where the dose is not sufficient to cause a sudden stoppage of the circulation, death will take place after a certain time from asphyxia, owing to the bronchial tubes becoming filled with frothy secretion. From the experiments of Von Bezold and Stezinsky (*Wurtzb. Physiolog. Untersuch.* p. 198) it seems that the irritability of the heart, at least as far as regards the number and strength of its contractions, is increased when the pressure of the blood in its cavities is augmented; and it is probable that the long continuance of the contractions of the heart when these substances are injected into the arteries is due at least in part to the effect of increased pressure, although I am inclined to the opinion that the substances themselves act as excitants to a certain extent, otherwise the heart's action would hardly have continued so long as 9 minutes after respiration had ceased. That the irritability of the ventricles should continue longer than that of the auricles is I believe owing to the thinner parietes of the auricles being sooner exhausted or fatigued when contracting for some minutes against such a great pressure. The increase of pressure that takes place in the arteries some minutes after the death of the animal admits of explanation by supposing that the passage of the blood containing the reagent through the smaller arteries and capillaries is completely arrested for some minutes. After a time however it passes into the veins and again through the lungs, and it is when the section of blood which is mixed with the largest portion of the reagent again comes in contact with the smaller arteries and capillaries, that the second and third increase in pressure takes place. This explanation involves the supposition of an almost complete arrest of the portal and systemic circulation for some minutes, and would prove that, at least under certain conditions, the heart's contractions must be independent of any supply of blood to its parietes, as a large

amount of force must be exerted by this organ while contracting for 5 or 6 minutes under a pressure of from 10 to 12 inches of mercury, and whilst, under the above supposition, the circulation over its parietes is suspended. The pulmonary arteries and capillaries, should the above considerations be correct, must offer much less resistance to the passage of the blood than the portal and systemic, as the blood is only delayed a few seconds in the lungs, although it is there mixed with the reagent in the greatest proportion. The sudden arrest of the respiration, and in fact apparently of all reflex and voluntary movement, is I think owing to an action of these substances on the nerve centres. The mere increase of pressure does not account for it, as respiration will continue under a pressure as great as was noticed in these experiments (see experiments with persalts of iron, *Journal Anat. and Phys.*, Nov. 1868). The occurrence of a few complete respiratory movements 3 or 4 minutes after they had been suspended might possibly be explained by the blood containing the reagent passing on so that the nervous centres became again supplied with less poisonous blood, which sufficed to restore to a certain extent the reflex functions of the respiratory centres. It is by this peculiar action in destroying the reflex action of the nervous centres that this isomorphous group is distinguished. The persalts of iron and its isomorphous compounds exert an analogous influence on the systemic circulation, but do not suspend the respiratory movements. These substances act also I believe as excitants of the muscular tissue of the heart, as it is only on such a supposition that we can explain the continuance of strong rhythmical contractions so many minutes after the arrest of respiration. In these two last points they differ from any other of the substances I have experimented with, and could thus be distinguished by their physiological action from any other isomorphous group.

THE ACTION OF THE HORSE. By NEVILLE GOODMAN, M.A. *St Peter's College, Cambridge.*

WHEN received theories have been found to be unreliable there is always a tendency on the part of those who would rectify them to run into an opposite extreme. This tendency is manifested in the article on the action of the horse which appeared in the May number of the *Journal of Anatomy.*

It is quite true that Sainbel's dictum that "the gallop consists of a repetition of leaps" conveys a false impression, for the leap by which a horse clears an obstacle differs utterly from the bound, which is a component of his stride when galloping. This statement, no doubt, gives currency to the popular fallacy that in the gallop a horse plants his hind feet in the same transverse line, then throws himself through the air lighting on his fore-feet, and finally brings up his hind-feet to them to repeat the process. This series of actions more resembles what a horse does in leaping when the leap is slow and the obstacle high, while it is precisely what he does *not* do in the gallop. Nevertheless the statement, that "the horse in the fast paces as in the slowest movement has never less than two of his feet acting on the ground," is quite incorrect; as can be shown by the diagram of the gallop given in Mr Gamgee's article. In that diagram it is evident, from the length of the stride, that the hind feet are brought to the ground after the play of the fore-feet in the prints which are behind them, and before these again reach the ground in front of them. Now, how could they be planted in these positions unless the fore-legs had first been taken from the ground? If it be supposed that this could be done by the alternation of the legs, so that, for instance, the off fore-leg should be plying the ground till the near hind-leg reached it; let any one try if he can make the alternate fore and hind-legs of a horse cross so that the hind-foot may overstep the fore one by 4 feet 7 inches, especially when both feet are on the ground. Reason and observation both demonstrate that there is a time in the stride in which all four legs are off the ground, or, in

other words, there is a bound in each stride. The popular fallacy consists in the supposition that the leap comes directly *after* the play of the *hind*-limbs, whereas the bound succeeds immediately after the play of the *fore*-limbs, and between each bound all four legs play successively, so that the animal is carried through a considerable distance before the ensuing bound. Doubtless the great propelling power of the horse, as of lighter animals, lies in the hind-limbs, and it is the impulse given by the action of these which carries him not only over the points of support offered by the fore-feet, but also through the subsequent bound. With so heavy an animal as the horse the play of the fore-limbs after the hind is necessary, in order to sustain his fore-quarters and to modify the line of motion through which his centre of gravity passes. Were it not for their action, the impulse of the hind-limbs on the centre of gravity would have to be more obliquely upward, and thus speed would be lost.

In Owen's last volume of the *Anatomy of the Vertebrates*, in page 68 the following passage is found:

"The gallop includes three combinations of movements of the limbs. When the horse begins the gallop on the right hind-leg, the left one reaches the ground first; the right hind and left fore-legs next, simultaneously, and the right fore-leg last; this is termed the *gallop of three beats.* In the gallop where the four legs strike the ground successively, the left hind-foot reaches the ground first, the right hind-foot second, the left fore-foot third, and the right fore-foot fourth; this is the 'canter', a *gallop of four beats,* but it is not the kind of movement adapted for great speed. The gallop wherein the legs follow the same order as in the trot—that is the left hind and right fore-feet reaching the ground simultaneously, then the right-hind and left fore-feet—is the order in which horses move their feet in racing, where the greatest speed is required, and is called the *gallop of two beats.*"

A similar statement in almost precisely the same words occurs in W. C. L. Martin's *History of the Horse* and in Percivall's article in the *Veterinarian* for August, 1844 (as a quotation from Lecoq); but as Professor Owen has not appended to his paragraph any reference, we must consider that he adopts

the ideas it contains. The description of the order of events which occur in the gallop of three and four beats contains nothing improbable or very different from the fact.

If a horse be attentively listened to, while galloping either fast or slowly on dry resonant ground, a sharp sound is first heard, then a more lengthened and confused one, and finally another distinct beat like the first. After this there is a pause of slightly less duration than that occupied by the whole series of beats. Comparing this oral testimony with that of the eye and also with that derived from a measurement of the footprints, we arrive at the following conclusions.

If the horse is galloping with his right fore-leg *leading*, the first sound represents the impact of the left hind-leg on the ground, the confused or double sound is from the right hind and left fore-legs, and the last sound is produced by the right fore-leg. The pause represents the time during which the right fore-leg plies the ground plus the time when all four legs are off the ground.

We may derive from the same observations the two following facts. First, there is no essential difference between the canter, gallop, and racing pace, and second, that the play of the right hind and left fore-legs are almost synchronous and parallel, the former preceding the latter by a slight interval only; while, on the other hand, the left hind and right fore-feet are never on the ground at the same time, and their action is relatively in opposite directions, that is, they relatively approach and recede to and from one another except at such time as all four legs are raised from the ground.

This being the case for all paces from the canter to the racing pace, it follows that the gallop of two beats with the explanation of it as an exaggerated trot, which is found in the above passage, is an impossibility. That such a statement, originating from a French author, should have been repeated so often on this side the channel, and finally adopted without acknowledgment by our leading comparative anatomist, is a proof how far mere compilation has taken the place of thoughtful digestion in the writers of the present day.

Mr Gamgee correctly observes, that in all paces no two

of the four feet are in similar positions, or acted on in like manner at the same instant. This is advantageous, first, by severing the forces in time and so rendering the motion more equable; and second, by allowing the feet to be placed in or near the same vertical plane as the centre of gravity, and so avoiding a loss of power by lateral obliquity and oscillation.

The observation that "midway between the two impressions of the near fore-foot prints is the mark of the near hind-foot," calls attention to a fact which is merely adventitious. This varies with different horses. Some horses cover the length of the stride mainly by the stretch of their limbs, while others do it by the distance they fling their hind-feet past the prints of the fore-feet, that is, by the length of the bound.

The horse from which Mr Gamgee took his measurements effected his stride more by the latter means than is habitual with other horses, the measurements of whose tracks have been taken by the writer.

NOTE ON SOME PECULIAR TUMOURS FOUND ON THE GASTEROSTEUS TRACHURUS. By LAWSON TAIT.

THE conditions of the struggle for existence seem to legislate that animals, save when domesticated, are very free from disease; and from the rarity of morbid affections, the study of comparative pathology has not attracted many workers, and notices of observations are not of ready access. It is quite possible, therefore, that the peculiar conditions in the stickleback which I am about to describe may have been noticed before; but I am unable to find any recorded instances.

Happening to pass for a few days successively along the bank of one of the many polluted becks of the West Riding, my attention was drawn to some sticklebacks living in the stream in spite of its impurity, many of which were decorated with little excrescences like white beads. My first impression was that these were parasites, and being anxious to determine their character I obtained some living specimens on March 26th. I found that, as a rule, the tumours were single, but in some cases two were present on one fish. They were variously placed, as in the anterior chamber of the eye; under the cuticle immediately above the orbit; on the shoulders; just above the anal fin; in the substance of the pectoral fin and of the tail; on the inner aspect of the operculum. The tumours were always capsulated, generally round but sometimes irregularly shaped; and they were loosely covered by the cuticle.

The substance of the tumours was of a milk white consistency and somewhat viscid. When this substance was removed from the living animal it was found to be composed of corpuscles of a peculiar shape and having a peculiar movement. In shape they resembled pears, a few were round, and some apparently constricted in the middle. They were constantly engaged in a slight vibratile movement which gave them a tendency to arrange themselves in lines. They did not, however, shew any tendency to adhere together as blood corpuscles do; and when two happened to touch after the addition of

water their movements were much exaggerated. This vibratile movement was continued for nearly twenty-four hours after the removal of the corpuscles from the animal, was most apparent when water was added, and was not affected by boiling or by any chemical reagent except caustic soda, and even that powerful substance only rendered the movement sluggish and destroyed it slowly. Boiling in caustic soda did not destroy the corpuscles although it rendered their outlines more indistinct. The contour of the corpuscles was affected only by prolonged maceration in water. They were nucleated, but this could not be determined until they were macerated in an ammoniacal solution of carmine. Their greatest measurement was about $\frac{1}{10000}$ of an inch.

I kept some of the diseased fish for many weeks in a vase along with some others from the same beck and free from the tumours; but I did not find any change in the characters of the tumours, although specimens were carefully examined from time to time; nor did any tumours become developed in those free from them. On June 19th I examined three diseased fish, the last I had, when a most interesting change was observed. When I squeezed the tumour-substance between the cover and the slide, I found that it contained gritty particles of some size. These were separated and washed and found to consist of masses of the corpuscles fused together. The addition of strong nitric acid to those particles rendered them softer and evolved a few small bubbles of gas, but did not alter the contour of the corpuscles. The movements were the same as formerly mentioned. Were these in process of cure?

I can offer no suggestion as to what these tumours may be, save the hint of my friend Prof. Cleland, that they may be strumous abscesses. Etiologically this is not unlikely, but not otherwise. I am not aware of any researches on inflammation in fish save those of my late friend M^c Kenzie Edwards, and these unfortunately were not published.

ON THE SO-CALLED SELECTIVE ABSORPTION BY THE LACTEALS AND LYMPHATICS. By W. H. BROADBENT, M.D., *Lecturer on Physiology, St Mary's Hospital.*

FROM the time of the discovery of the Lacteals and Lymphatics a power of discrimination has been attributed to these vessels as to the substances taken up by them. At first the Lacteals were considered as the sole or at least the main channels by which the nutrient material derived from the food entered the blood, but this erroneous idea was soon corrected, and they are generally recognized to be secondary in point of importance to the blood-vessels in this respect. Up to the present time, however, it is held that there is something special and peculiar in their function,—that whereas the capillary blood-vessels take up whatever is capable of passing through membranes by diffusion, and absorption as exercised by them is a process explained and regulated by physical laws, the lacteals have a power of selection and receive only the oleo-albuminous matters which constitute chyle, rejecting poisons and the like. This is an acknowledged difficulty, for the explanation of which there have been advanced the most extraordinary accounts of the intestinal epithelium, and of the structure of the villi, with other hypotheses equally unsatisfactory. The object of this communication is to shew that this 'Selective Absorption' is apparent only, and that it is another exemplification of the physical process of liquid diffusion.

The lacteals and lymphatics are parts of the same system, the former differing in having a special purpose in relation with the digested food, but in structure and function they are essentially similar, and it will be an advantage to consider them together, the lymphatics presenting the problem of function in a simpler form.

As to structure it seems now to be very generally admitted that the commencing lymphatic plexuses are simply the interstices between the fibres of the textures from which start delicate vessels with distinct walls. Some observers say that these interspaces have a thin epithelial lining, but this is not

important. It is not so evident that the lacteals are mere intertextural spaces; but this is asserted by His on very good grounds, and it is extremely probable that it is so, the greater minuteness and regularity of the network as seen by injections resulting from the arrangement of the glands and crypts of the intestinal mucous membrane. It is clear, whether these commencing lacteals have proper walls or not, that they occupy all the intervals between the capillaries, glands, and fibres, and at most they can have only a delicate epithelial lining. From the structure alone then we should be justified in putting down Selective Absorption as impossible; mere spaces cannot attract any particular substance.

When the conditions under which the absorption by the lymphatics takes place are considered, it is at once evident that the process is merely passive. Under the pressure of the blood in the arteries a certain amount of fluid exudes from the capillaries for the nourishment of the tissues. Not only do the tissues abstract from this fluid the materials for their construction, but it is the medium in which the process of oxidation takes place, and in which the products of oxidation and disintegration are primarily found. It is constantly being charged therefore with carbonic acid, urea, &c. We have thus a fluid in the interstices of the tissues containing carbonic acid, &c., and in the capillaries the blood containing oxygen. Mutual interchange of diffusible constituents will necessarily take place in accordance with the law of diffusion till the two fluids reach the same level of composition, and thus by the time the blood has arrived at the venous side of the capillary network it will have lost its oxygen and taken up carbonic acid, &c., converse changes occurring in the interstitial fluid. But while the diffusible products of oxidation thus find their way from the interstitial fluid to the blood-current, the non-diffusible colloid matters which have traversed the delicate capillary membrane outwards under pressure, cannot return against pressure, and must remain in the intertextural spaces which are no other than the commencing lymphatics. The lymphatics then cannot be said to exercise absorption in any sense whatever, they simply receive the spare nutrient material which is forced onwards by the continued exudation of fresh fluid from the

capillaries, and finds its way along the vessels to the thoracic duct.

Examining now the conditions under which Lacteal Absorption occurs, we have the intestinal mucous membrane bathed in the products of digestion consisting of salts, sugars, peptones, and fats in solution or suspension in water, together with the constituents of the digestive fluids. The epithelium and subjacent structures are saturated with these matters, and they all, even the fatty substances in small proportion, find their way into the capillaries. We do not perhaps altogether understand the one-sided diffusion which results in the transfer of all the soluble contents of the intestine to the blood, but we are justified in referring the general absorption from the intestinal surface to the osmotic process, aided possibly by pressure. Without however dwelling on the passage of the various products of digestion through the epithelial layer and basement-membrane, it must be pointed out that in order to enter the blood-vessels, a second membrane, the capillary wall, must be traversed. All the matters, salts, sugar, albuminose, and fat, must in fact on first penetrating the basement-membrane find themselves in the interstices of the textures, *i. e.* in the interspaces which, whether lined by epithelium or not, constitute the commencing lacteal plexus, and they will pass thence through the capillary wall in the order of their diffusibility, salts most rapidly, then sugar, then peptones, and lastly fats. A small proportion of the fatty matters is found to enter the blood in this way, but being greatly inferior in diffusibility even to the peptones, the fat is left behind in the intertextural spaces by the other constituents, and by its predominance arising in this way gives the chyle its characteristic composition and properties.

The lacteal absorption is thus not selective and special but general and residual, and the office of the lacteals is not the abstraction from the mixed contents of the intestine of the fat as an ingredient of special value, but to prevent the waste of this valuable ingredient by providing a readier mode of access to the blood in the place of the slow diffusion through the capillary walls which would result from its high osmotic equivalent.

THE MYOLOGY OF THE LIMBS OF THE UNAU, THE AÏ, THE TWO-TOED ANTEATER, AND THE PANGOLIN[1]. By PROFESSOR HUMPHRY. (Pl. I, II, III, IV.)

I WILL make a few preliminary remarks respecting the carpus, tarsus, and digits, of these animals (see Pl. I.). The first or proximal row of the carpus, in Unau, Aï, and Antr presents the usual complement and arrangement—*scaphoid*, *lunar*, *cuneiform*, and *pisiform;* the first two being articulated with the radius, the cuneiform with the ulna, and the pisiform with the cuneiform. In UNAU the ulna is short and terminates in a cone-shaped epiphysial end, which though deeper than that of the radius does not descend quite to the same level with it[2]. To make up for the deficiency, the cuneiform is of nearly cylindrical shape. In Aï, the scaphoid, lunar and cuneiform form a segment of a sphere, which revolves in a cup formed by the radius and ulna; these two descending to the same level. In both the scaphoid is continued internally into a process which projects on the inner side of the distal row, and comes into contact with the base of the representative of digit I. In ANTR the three bones are disposed as in Aï; but the scaphoid is shaped like the lunar, and the convex surface which they present to

[1] For opportunities of dissecting the Unau (*Bradypus, vel Cholæpus, didactylus*) and the Aï (*Bradypus gularis vel tridactylus*), I am indebted to the kindness of Mr Flower, of the College of Surgeons. The muscles in the Unau had unfortunately undergone decomposition to a considerable extent in the upper segments of the limbs, especially of the fore limbs, so that they could not be made out. The two-toed, or little, Anteater (*Myrmecophaga didactyla vel Cyclothurus didactylus*) is in the Cambridge Museum. All the specimens had been long preserved in spirit. Representations of the muscles of Aï and the two-toed Anteater are in Cuvier and Laurillard's Plates. A description of the anatomy of the two-toed Anteater has been given by Meckel in his *Archiv für Physiologie*, v. 1, and of the muscles of that animal as well as of the Aï in his *System der vergleichende Anatomie*, III. Meckel makes occasional mention of the muscles of Unau, and Mr Galton does the same in his article on Dasypus, *Trans. Linn. Soc.* XXVI. Dr Macalister has recently written on the myology of Bradypus tridact., *Annals and Mag. of Nat. Hist.* June, 1869.

The Pangolin (*Manis Dalmanni*), sent me by Mr Flower, arrived after I had written out the description of the others. The sternum and right scapula had been taken out, and the muscles of course were thereby a good deal mutilated. I have not met with any description of the muscles of this animal. The specimen is a male, measuring 27 inches from the tip of the nose to the end of the tail, and the tail is 11 inches. There are five clawed digits on each limb. The almost cylindrical tongue protrudes 9 inches from the mouth.

[2] The corresponding epiphysis in a young specimen of Aï is also long and conical.

the radius and ulna is less sharply curved than in Aï: the *pisiform* is very large.

The distal row in Aï and ANTR consists of two large bones—the *unciform* and *magnum*—which occupy the concavity formed by the proximal row. In UNAU the *magnum* is small; the *trapezoid* occupies its usual place, and the *trapezium* is partially ankylosed to Met. I[1]: the trapezium looks like a part of the metacarpal, and might be supposed to be an incompletely ankylosed proximal epiphysis, being on the same level with the proximal ends of the other metacarpals; but it is no uncommon thing when the pollex is absent, or nearly so, for the trapezium to extend, more or less, alongside the metacarpals, and even to resemble them in shape. This is so in Cyclothurus (Pl. I.), in the Elephant, and great Armadillo (*Priodon gigas*); and the same thing is more frequently observed in the case of its homologue, the ento-cuneiform, in the hind limb.

The metacarpals and digits in all are parallel, close together, and admit of no lateral movement; and the flexion and extension is almost confined to the ungual phalanges. In UNAU two digits only (II. & III.) are fully developed; of these Met. II. rests upon the trapezoid, and Met. III. upon the magnum extending upon the unciform. Met. I, partially ankylosed with the trapezium, terminates in a nodular end one-third from the distal end of Met. II. Met. IV. is not directly connected with the unciform, but rests upon the part of the end of Met. III. which is articulated with the unciform. It terminates in the same manner as Met. I. about one-third from the distal end of Met. III, but has an epiphysis at its distal end. There is no trace of Met. V. The first phalanges are very short and so articulated with the second and with the metacarpals, especially with the latter, as to permit very little movement, foreshadow-

[1] In a young specimen in the College of Surgeons these two are separate; in a specimen of an older animal they are quite united.

Owen, *Comp. Anat.* II. 306, considers that the scaphoid and trapezium are, in this and similar instances, united into one carpal ossicle—a scapho-trapezium—and would regard what I take to be the trapezium as the epiphysis of Met. I. In the hind limb, however, of the three- and according to Owen (p. 413) to some extent in the two-toed Sloth there is a fusion of the tarsals and metatarsals corresponding with that which I suppose to have occurred between the trapezium and the first metacarpal. Moreover, a certain amount of downward prolongation of the inner part of the scaphoid is not uncommon, and as I have said, above, the trapezium not unfrequently descends alongside Met. II.

ing the more coalesced condition in Aï. The epiphyses are separate at the distal ends of the metacarpals and at the proximal ends of the second phalanges; but no epiphyses are discernible in the first or distal phalanges.—In Aï the magnum carries Met. II. and the greater part of Met. III; and the unciform carries Met. IV. and part of Met. III. There are only two phalanges (2nd & 3rd) in each of these digits, the first being united with the metacarpal forming a 'metacarpo-phalangeal,' with which the second phalanx is so connected as to permit scarcely any movement. The elongated outgrowth at the inner side of the base of Met. II., which is the representative of digit I, rests slightly upon the process of the scaphoid abovementioned, which descends to the metacarpal level. This outgrowth is probably the representative of the distal carpal as well as the ray elements of digit I. Digit V. is represented by a process similar to that for digit I., but much smaller[1].

In ANTR digit II. has a metacarpal and three phalanges, the first and second being closely articulated. In III. the first phalanx is short[2], and for the purpose of giving strength to this large middle digit is ankylosed to the second phalanx and closely jointed with the metacarpal. In digit IV. the first phalanx is absent or fused; at least this digit consists of a metacarpal and two phalanges, which are minute, do not project the skin and are not unguiculated. Digit V. is represented only by a short metacarpal which rests upon a small facet on the ulnar side of the unciform. Met. IV. and one half of Met. III. are articulated with the unciform; and the other half of Met. III. and Met. II. with the magnum. The remainder of the carpus (trapezoid and trapezium) with the pollex are represented by a small conical bone articulated with the magnum, having its

[1] In a young specimen of Aï in the College of Surgeons these processes are separate nuclei on the sides of, but not connected with, the adjacent metacarpals; and the first phalanges are also separate though closely adapted to the metacarpals in a wavy line. I cannot distinguish epiphyses at either end of the metacarpals or of the first phalanges; but the epiphyses at the proximal ends of the second phalanges are clearly seen, and those at the proximal ends of the third phalanges are visible though less clear. In a young specimen of Unau the epiphyses at the distal ends of the metacarpals are seen as they are in the example before me.

[2] There is, apparently, a similar ankylosis of the first and second phalanges of the middle digit in the fore and hind limbs of the Megatherium, and in the middle digit in the great Antr. In the three outer digits in the six-banded Armadillo, and in the great Armadillo the first phalanges are short and closely jointed with the second.

base resting upon the scaphoid, and carrying a small supernumerary bone upon its inner side. Thus digits I. and V. have only a rudimentary existence; digit IV. has a metacarpal and two phalanges; and digits II. and III. have the usual complement; but in III. the first phalanx is ankylosed to the second.

It will be perceived that provision is in all made for concentration of force upon a hook which is formed chiefly from one—the middle—digit. This digit (to which, even in man, the others may be regarded as subsidiary) rests upon the unciform as well as the magnum, and is thus made to subtend the line of the ulna as well as of the radius. The digits on either side are, in ANTR, quite subordinate, and in AI and UNAU are, by their parallelism and close juxta-position to the middle, made to be practically one with it.

The *order of suppression* of the digits is clearly traceable. Nos. I. and V, neither of which attains in any mammal to the full carpal and ray complement (a phalanx being missing in the one and a separate carpal bone in the other) are but feebly represented in all these animals. The traces of the two are about equal in Aï and ANTR; but in UNAU there is no trace of V, although both the carpal and metacarpal elements of I. (partially ankylosed it is true) are fairly represented. No. II. has its full carpal and ray complement in UNAU, and its proper ray complement in ANTR; whereas No. IV. is represented only by a short metacarpal in UNAU, and by a metacarpal and two phalanges in ANTR. It is seen, therefore, that the instability is greatest in I. and V, and rather greater in V. than I, is next manifest in IV, is least in II. and III, and is least of all in III. This does not altogether correspond with what is usually observed in mammals; in them digit I. is more often imperfect or absent in both limbs than any other. In the hind limb, however, of birds and the crocodile I. is present, though V. is absent or nearly so.

The order of suppression of the other digits also is somewhat variable in mammals. In UNAU and ANTR, as we have seen, II. and III. remain, No. II. being subsidiary in ANTR. In Ruminants III. and IV. are the large hoofed digits, II. and V. being mere splint bones, and I. being absent altogether. In the hind foot of the Kangaroo IV. is the large toe, V. is smaller, II. and

III, though clawed, are of extreme thinness, and I. is wanting; and in the hind foot of Megathere I. and II. are wanting. In short there appears to be no rule.

As regards the *manner* of suppression of the digits, it would seem to take place in two ways, either longitudinally, when certain elements are abortive or two or more become blended into one during growth by fusion or ankylosis of the osseous nuclei, or, laterally, when there is in some instances a blending of one or more elements of the digit with those of an adjacent digit. An example of the first (the longitudinal) mode is afforded by the ordinary condition of digit I, in which there is a suppression of a phalanx; and an example of the second (the lateral) mode is afforded by the ordinary condition of digit V, a carpal element of which is connate with a carpal element of IV. forming the unciform bone. Both of the modes are often seen together. Thus in Aï the carpal and ray elements of I. and V. are blended, longitudinally, into short stumps which again are blended, laterally, with the adjacent metacarpals. Moreover the separate phalanges in each of the remaining digits are reduced to two, of which one (the second) is scarcely separate from the first, while this (the first) is quite ankylosed to the metacarpal. In UNAU, where V. is quite wanting, the phalangeal ray elements of I. and IV. are absent, never having been produced, or having faded during development, or, possibly, being blended, longitudinally, into what presents itself as a short metacarpal; and this in I. is partially blended with the carpal element, and in V. rests upon IV, as if preparatory to a lateral union with it, similar to that which has taken place in Aï. In digits II. and III. the first phalanges are short and closely united to the metacarpals, which may be regarded as an approach to the fusion with them that has taken place in Aï. In ANTR there is a tendency to fusion of the first and second phalanges, which appears to have occurred in digits III. and IV. The ray elements of V. are reduced to a short metacarpal; and in I. the ray and carpal elements are all reduced to a single rudiment, which is blended with the carpal element of II: at least there is only one bone to represent all these parts[1].

[1] In Armadilloes and some others the tendency to imperfect cleavage or to subsequent union (judging from the closer adaptation and the appearances in

On the inner side of this small bone in ANTR is an ossicle corresponding evidently with the supernumerary sickle-like ossicle of the carpus in the Mole, many Rodents and others. It may probably be referred to the same category as the pisiform bone, being, like it, rather an appendage for the purpose of muscular attachment and not being, like the true carpal bones, in the line between the bones of the forearm and those of the digital rays. The downwardly projecting part of the scaphoid in UNAU and AÏ seems to represent the separate ossicle and to serve the same purpose.

In *Manis* the *scaphoid* and *semilunar* are united into a scapho-lunar bone. The other carpal and ray elements present the ordinary mammalian number. The first phalanges are short and closely articulated with the second in digits III. and IV. and especially in III, foreshadowing the union of the two which has occurred in Antr. The terminal phalanges are long and bifid.

HIND-LIMB.

The *astragalus* in all is large and presents anteriorly a cup which receives a conical projection of the scaphoid. This serves to facilitate that rotation of the distal part of the foot upon the astragalus which permits the inturning of the sole so marked in the Sloths, at the same time that it is a security against displacement of the bones. In AÏ and UNAU it presents a still more remarkable cup, above and externally, which receives a conical projection of the lower end of the fibula and which assists in the rotation just mentioned at the same time that it affords an effectual provision against displacement of the tarsus outwards under the powerful pull of the tibialis anticus, such a provision being especially needed in the inturned position of the foot[1]. The deep collar covered by cartilage which sur-

Priodon, Dasypus and Megatherium) appears to be between the first and second phalanges rather than between the first phalanx and the metacarpal; and I think as a general rule the variability of the ray elements above or below the ordinary number is caused by suppression or multiplication of the first and second phalanges. That is to say, the metacarpals and the terminal or clawed phalanges retain their individuality; and the variations in number take place between them; that this however is not without exception is shewn by the example of AÏ where the metacarpal and first phalangeal shafts have grown together.

[1] In Megatherium the same result is attained by a ball-like projection of the inner part of the articular surface of the astragalus fitted to a cup in the lower end of the tibia.

rounds, or forms the edge of, this cup is thick at the inner part where it is received into the concavity formed by the tibia and the inner side of the conical process of the fibula. In UNAU this acetabular cup is situated more on the outer aspect of the bone; and the inner edge is thicker than in Aï, whereas the outer edge is incomplete or interrupted, and the interval is occupied by a strong ligament—the posterior peroneo-tarsal—which extends to the bottom of the socket, and which, externally, is connected with the outer and hinder aspect of the lower end of the fibula. The similarity of the disposition of this ligament to that of the ligamentum teres of the hip-joint is very striking[1]. It is however covered by synovial membrane in a part only of its circumference. In Aï the ligament is much weaker and passes to the exterior of the outer edge of the acetabular cup which is complete though lower than the rest of the circumference. Indeed it presents a slight notch here[2]. The other bones of the tarsus present no very remarkable peculiarities.

In UNAU the scaphoid is small and is covered on its inner side by the elongated ento-cuneiform which presents a concave surface for the tendon of the tibialis anticus. The ento-cuneiform extends, like its homologue in the carpus, below the level of the other cuneiforms. The metatarsals have their distal epiphyses; and there is a slight unevenness near the proximal ends suggestive of lines of union of epiphyses. [See paper by Prof. Allen Thomson, on the ossification of the metacarpal and metatarsal bones in this *Journal*, III. 131.] Digits II. III. and IV. are long and clawed, whereas I. and V. are represented only by their metatarsals which are two-

[1] It may be remarked that the ligamentum teres is absent in UNAU and Aï, and the spherical head of the femur has accordingly no dimple. There is however the usual space devoid of cartilage at the bottom of the acetabulum, and this is large in Unau. In ANTE the ligamentum teres is present. In MANIS the ligament is absent: there is a slight unevenness at the part of the head of the femur where the dimple usually is; and there is the space devoid of cartilage at the bottom of the acetabulum, but it is small.

[2] In monkeys, in which the foot is also inturned, elongated, and adapted for clinging as in the sloth, there is a similar, though less marked, concavity on the outer surface of the astragalus adapted to a slightly convex surface of the fibula, and the post. peroneo-tarsal ligament is very strong, in the Proboscis Monkey at least, is inserted more forward than in man, more in the bottom of the concavity of the astragalus just mentioned, and does not approach the groove for the flexor digitorum fibularis. Indeed this Monkey presents an arrangement intermediate between that of Man and that of the Unau.

thirds of the length of the other metatarsals. Met. I. has an epiphysis at its proximal end. Met. V. does not rest upon the cuboid but upon the outer part of Met. IV. and has a small epiphysis upon its distal end. The first phalanges are short and closely articulated both with the metatarsals and with the second phalanges. Neither in them nor in the distal phalanges are any epiphyses visible, but the epiphyses at the proximal ends of the second phalanges are separate from the shafts.

In Aï the os calcis is very long. The scaphoid, three cuneiform bones and three inner metatarsals are united into one bone; and the same is the case in an articulated specimen in the Cambridge museum with regard to the cuboid and two outer metatarsals (IV. and V.). Mets. I. and V. are processes from II. and IV. as in the fore-limb[1]. The first phalanges are connate with the metatarsals. The dotted lines in the drawing represent unevennesses which indicate the lines of union of the phalanges with the metatarsals (Pl. I.).

In ANTR the ento-cuneiform is broad and flat overlapping the meso-cuneiform. It carries metatarsal I. at the extremity of which is a single rather long phalanx concealed by the skin and not furnished with a claw. On the inner side of the ento-cuneiform, articulated with it and slightly with the anterior and inner edge of the scaphoid[2], is a long, broad, flat, supernumerary bone which projects into the sole, reminding us of the hallux in some of the quadrumana and supporting the inner side of the broad thick cutaneous pad which serves as an opponent to the four digits. Its summit and that of os calcis are nearly on a level; and the two are connected by tendinous tissue which, as well as the two bones, assist to carry the pad. It corresponds with the supernumerary bone on the inner side of the carpus and may be referred to the same category with it. The first and second phalanges are closely articulated in all the four outer digits, exhibiting the same tendency to union as their counterparts in the fore-limb.

[1] In a specimen in the College of Surgeons the scaphoid, cuboid, three cuneiforms, and all the metatarsals are united, forming one bone. In a young specimen in the same museum these are all separate, and the rudimentary metatarsals of I. and V. are also separate as in the fore-limb.

[2] In the drawing it is detached a little from the scaphoid to shew the extent of the entocuneiform.

In MANIS the tarsal and the ray bones accord in number and general characters with those usual in mammals. As in the fore-limb the first and second phalanges are closely articulated together and the terminal phalanges are bifid.

MUSCLES OF THE FORE-LIMB.

Pectoralis Major in the ANT-EATER consists of two strata, a superficial stratum arising from the sternal end of the clavicle and the surface of the sternum, and a deeper stratum arising from the edge of the sternum and the adjacent parts of the costal cartilages. The fibres of these strata have different directions. Those of the superficial stratum are directed *back*wards and outwards towards the lower part of the pectoral crest of the humerus; whereas those of the deeper stratum, crossing the preceding obliquely, are directed *for*wards and outwards towards the upper part of the pectoral crest. The two are united behind by the superficial fibres curling into the deeper; so that when the superficial layer is reflected to the axillary edge of the muscle the two strata form one sheet. The deeper stratum is, near the sternum, continuous with the pectoralis minor.

In Aï the pectoralis major has been detached from the sternum, so that I cannot determine its origin. It is inserted into the pectoral crest.

In MANIS it has evidently been attached along the whole length of the sternum and to part of the linea alba. Its fibres converge to the pectoral crest of the humerus, those from below crossing beneath the others to the middle of the crest; but the chief part of the tendon of the muscle is inserted very low down below the middle of the humerus.

Pectoralis minor (Aï), from 2nd, 3rd, 4th, 5th, and 6th costal cartilages close to the sternum. The fibres converge to a tendon which is quite distinct from that of the pectoralis major and is inserted, above it, into the outer tubercle of the humerus[1]: (ANTR), from the three anterior sternal ribs[2], to the

[1] I find this muscle to be, as represented by Cuvier and Laurillard, quite distinct. Meckel and Macalister do not admit its presence.

[2] The first sternal rib is represented by a lateral process of the manubrium sterni.

upper part of the outer tubercle of the humerus. I could not discover any traces of it in MANIS; but it may have been present as the parts were a good deal mutilated.

Subclavius (Aï), a thin muscle arising, tendinous, from the large 1st rib near the sternum. It becomes muscular and expands as it passes outwards and is inserted slightly into the under surface of the rudimentary clavicle[1], but chiefly into the inner edge of the coracoid process. In ANTR it is not separate from the pect. min.[2]

These muscles, *pect. major* and *minor* and *subclavius* belong, apparently, to one group which may be called the 'pectoral' or 'brachio-sternal' group and which presents different degrees of segmentation or separation into layers and sectors in different animals. The blending of the subclavius with the pect. minor and the close connection of the combined muscle with the deeper stratum of the pect. major in ANTR are worthy of note with reference to this, as is the attachment of the subclavius to the coracoid (the frequent point of insertion of the pect. minor) in Aï. The varying degree of segmentation or separation of these muscles in different animals or in different specimens of the same animal affords some explanation of the discrepancies in the description of them by different anatomists[3].

[1] The gradations of the clavicle in the four animals are curious. In MANIS it is absent. In Aï it is a mere scale attached to the inner edge of the coracoid which is large and projects forwards to a level with the acromion. A long ligament, the remnant of the structures of which its proximal part was originally composed, connects its inner end with the sternum. In the young state the cartilage of the acromion is continued to the coracoid and the clavicle, but subsequently retires leaving the clavicle upon the coracoid. (Parker, *On the Shoulder-girdle*, p. 200.) In UNAU the clavicle is articulated externally with the acromion which remains continuous with the coracoid, and is much longer; still it does not quite reach the sternum, a strong ligament (the degenerated 'omosternum' of Parker, *l. c.* p. 200) connecting it with the sternum. In ANTR the clavicle reaches the sternum, and is connected with it by a tough fibrous substance, which passes behind the edge of the manubrium, and which contains an ossicle (the 'omosternum' of Parker, *l. c.* p. 203) like that found in the Rat and some other Rodents.

[2] Meckel makes no mention of the muscle in this animal, and it is not represented by Cuvier. It appears to be absent in the other Anteaters and the Armadilloes, but is present in Orycteropus. I find no trace of it in MANIS.

[3] In both Aï and ANTR a strap-like muscle arises from the hinder edge of the broad first rib behind, and extending outside of, the insertion of the scalenus, runs backwards across the ribs, and is inserted into the 7th and 8th ribs, external to their cartilages, between the obliq. ext. and the serratus magnus. Meckel (*Arch.* v. 41 b.) describes it in Antr as the pect. minor; but there seems no sufficient reason for this. It has not the direction or disposition of that muscle, and it co-exists with a distinct pect. min. in Aï. It seems rather to correspond with an extension of the scalenus backwards, which is not uncommon. It is called *rectus thoracicus lateralis* by Macalister in his description of Aï; but it can scarcely be a detached slip of the rectus abdominis which lies deeper.

The *scaleni* are represented in ANTR by fibres descending from the four lower cervical transverse processes to the first rib behind the subclavian vessels.

Brachio-lateralis: under this name I propose to include a muscle or series of muscles which has been described by different writers in different animals as *pectoralis quartus, latissimus dorsi secundus, abdomino-humeralis, brachio-abdominalis, costo-humeral*[1], and the disposition of which is very much implied by the various names which have been given to it. It is, above, attached to the humerus, usually to the pectoral crest or the great tubercle, beneath and in more or less close connection with the pectoral muscles, but sometimes to the ridge on the inner side of the bicipital groove, in front of and more or less closely connected with the latissimus dorsi. It passes backwards through the axillary opening between the pectoralis and the lat. dorsi and radiates upon the side of the trunk, passing over the external oblique, and extending, it may be as in Orycteropus and Phoca[2], over the buttocks, thighs and knees, and frequently extending upon the back and covering the latissimus dorsi. In some animals or in some parts (Pteropus[3], Rat, Mole, &c.), it is subcutaneous and closely connected with the skin, forming part of the pannicle, and might be called 'brachio-cutaneous'. In other animals, or in other parts, it is attached to the ribs and might be called 'brachio-costalis'.

In Aï a muscle arises from the hinder surface of the 9th cervical transverse process, and is inserted into the anterior edge of the first rib, and resembles an interosseous; and a thin muscle passes from the extremity of the 8th transverse process, behind the subclavian vessels, to the 2nd rib.

The transverse processes of the 9th cervical vetebræ in Aï are large, truncated and projecting, and correspond with the hinder parts of the transverse processes above them; those of the 8th vertebra are shorter and present both the anterior and the posterior parts usually appertaining to a cervical transverse process with the foramen transmitting the vertebral artery. There are no floating rib-appendages to either the 8th or 9th cervical vertebra in this specimen, though such are present in the articulated skeleton in the Cambridge Museum, and are commonly found in this animal.

A muscle, which may be regarded as a continuation forwards of the obliquus externus abdominis (it is so described by Meckel), arises from the hinder half of the sternum beneath the pectorals, spreads out, the direction of its fibres being chiefly forwards and outwards, and is inserted into the five foremost ribs indigitating with the serratus; and the hindmost fibres are continued into the serratus. It may be called *sterno-costalis superficialis.*

Beneath the last-mentioned and the external oblique is the broad fore part of the rectus abdominis passing forwards, with slight inclination of its fibres outwards, and inserted into the several ribs as high as the first.

Beneath this again is the muscle described by Meckel (*Arch.* v. 41 c), arising from the four anterior bones of the sternum with its fibres directed backwards and outwards and inserted into the ribs from the 2nd to the 6th.

[1] See Macalister in *Ann. and Mag. of Nat. History*, July, 1869.

[2] Vol. II. of this Journal, p. 294.

[3] In Pteropus (Vol. III. of this Journal) it is attached above to the coracoid process, and I have, consequently, called it 'coraco-cutaneous'.

It is to avoid the exclusive significance of either of these names that I venture to give the name 'brachio-lateralis'. In some, as in Manis (see below), its fibres are closely, inseparably, blended with those of the external oblique. At its humeral end it often appears like a segmentation from the pectoralis major or latissimus dorsi, and in its abdominal part it has frequently been confounded with one or other of these muscles. This is the more likely to occur, because the abdominal fibres both of the pectoralis major and of the latissimus dorsi usually ascend on the axillary side of the respective muscles, therefore close to the fibres of the brachio-lateralis. Moreover, its costal and its superficial lateral part is often closely connected with and likely to be confounded with the hinder part of the latissimus dorsi; and crossing, as it sometimes does, from an origin with the latissimus dorsi to an insertion with the pectoralis major, it may unite the two muscles and form the 'Achselbogen' of German anatomists. Indeed, it not unfrequently is difficult or impossible of separation from one or other of the adjacent muscles—the pectoralis major, latissimus dorsi, obliquus externus abdominis, and the pannicle—and it forms more or less of a bond of union between them.

Speaking generally I would say the muscular series which radiates, funnel-like, from near the pectoral crest of the humerus is divisible into four great sectors, a 'brachio-sternal' (the pectorales), a 'brachio-lateral,' a 'brachio-lumbar' (the latissimus dorsi), and a 'brachio-cervical' (the deltoid and trapezius or delto-trapezius).

In Aï the *brachio-lateral* is attached, above, to the upper part of the pectoral crest, between the pectoralis major and minor, passes backwards beneath the pectoralis major, appearing as a deeper stratum of it, and expands upon the abdomen on the rectus and obliquus externus. Towards the hinder part of the abdomen it contracts and is continued upon the front and outer side of the thigh, being lost in the fascia about the knee. It has a close connection with the 7th rib on its way; but most of its fibres are continued over the rib. I cannot trace its fibres directly into the skin in any part of its course. In ANTR also it looks like a division of the pectoralis major, being attached above by a thin tendon to the upper part of the pectoral crest. Behind, it radiates over the abdomen, some of its deeper fibres

being attached to the 8th and 9th ribs just behind the rectus thoracicus lateralis, while its superficial fibres become united with the pannicle spreading over the latissimus dorsi, the obliquus externus abdominis, and the outer part of the thigh nearly to the knee. It here becomes connected with the fascia of the thigh; and some of its fibres may be traced with the fascia to the femur between the vastus externus and the glutæus maximus, constituting a 'femoro-cutaneous', like that in Pteropus; except that in Pteropus (Vol. III. p. 300) the muscle, in consequence probably of the different rotation of the limb, is connected with the tibial side of the femur.

In MANIS it has very extensive relations. Above, it is connected with the inner bicipital ridge and the inner tubercle of the humerus by a flat tendon, internal to and distinct from the latissimus dorsi. As it passes backwards the greater number of its fibres are separated from the latissimus dorsi by the brachial nerves and vessels; some however pass behind these with the lat. d. They take a course superficial to the lat. d., are not attached to the ribs and come into connection with the fibres of the external oblique and the pannicle, and are inextricably interlaced with both. At the hinder part of the abdomen the fibres again become separate from the external oblique; at least, muscular fibres are continued over the outer side of the thigh and knee and are lost upon the fascia. The fibres of this conjoined brachio-lateral and external oblique are closely connected with the scale-covered cutis, but do not terminate in it, except to some extent over the buttock, where the fibres of the muscle run into the cutis. Also towards the fore part of the abdomen a superficial plane separates from the deeper stratum, as it runs forwards, and is lost in the skin over the back of the axilla and the hinder part of the scapula. This may perhaps rather be regarded as the pannicle separating itself from the brachio-lateral and the external oblique.

Omohyoid is absent in ANTR; and I find no trace of it in the others.

Sterno-mastoid, in ANTR, arises by a narrow tendon from the upper edge of the sternum close to the articulation with the clavicle and is inserted into the mastoid part of the temporal bone behind the ear.

Cleido-occipital, in ANTR, running parallel with and close to, but distinct from, the preceding, arises from the anterior edge and upper surface, slightly from the hinder surface, of the inner third of the clavicle, spreads and becomes thinner as it ascends and is inserted into the whole of the ridge of the occipital bone and the occipital crest; and some of its fibres meet those of the opposite muscle beneath the crest. It thus shuts off the trapezius from the occipital bone, occupying the part from which that muscle usually arises and quite filling up the upper part of the interval between it and the sterno-mastoid[1]. In the other three animals this muscle, if it existed, and the sterno-mastoid had been cut away or were decomposed.

Trapezius (Aï), cervical fibres delicate, scarcely traceable to the skull. It is inserted into the rudimentary clavicle, the coracoid, coraco-acromial ligament, acromion and spine of scapula. The hindmost fibres are continued into those of the deltoid. In ANTR it arises from the eight anterior dorsal spines and from the ligamentum nuchæ and, through it only, from the skull. It is inserted into the spine of the scapula, the acromion and the outer third of the clavicle; above, its fibres are in contact with those of the cleido-occipital; but, below, the two muscles are separated by a considerable interval.

In MANIS the trapezius is large. It arises from the occipito-mastoid ridge, as far forwards as the ear, from a fascia uniting it with the opposite muscle in the neck and from the upper dorsal spines. It is partially inserted into the spine of the scapula; but the greater number of its fibres, forming a thick mass, pass over the scapular spine and the shoulder-joint and are inserted into the prominent pectoral crest; and a thick bundle of its foremost fibres is continued from the pectoral crest on to the inner condyle, and is inserted into it and into a tendinous band extending from the pectoral crest to the inner condyle. This band and the muscle bridge over a space through which passes the biceps muscle. Behind this space

[1] Meckel describes the 'Kopfnicker' as consisting of three parts, one corresponding with the sterno-mastoid and the other two with the cleido-occipital of my description. In my specimen the clavicular part is not divisible into two, though there is some crossing of the fibres, those arising foremost and innermost crossing superficial to the others and being inserted hindmost.

is the bone forming the anterior wall of the supra condyloid foramen through which passes the medium nerve.

This extension of the trapezius below the shoulder is no doubt the representative of the fore and larger part of the deltoid, the two muscles being continuous as is often the case where the clavicle is absent. I say continuous; but I should observe that there is to be seen in places a faint transverse tendinous inscription where the muscle passes over the shoulder.

Occipito-scapular[1] (Pl. IV. fig. 1 *o.s.*) is large in MANIS, arising tendinous, immediately beneath the trapezius, from the occipital ridge and from the ligamentum nuchæ all along the neck. It passes over the supra-spinatus muscle and is inserted into the upper edge of the spine of the scapula in nearly its whole length. Situated between the trapezius and the splenius the direction of its fibres is more in the axis of the trunk than it is in either of those muscles; but its general disposition indicates it to be a segmentation from the trapezius. A thin slip detaches itself from the hinder part and, passing along the base of the scapula, is inserted into it opposite the divergence of the spine.

This corresponds with the ordinary insertion of the lesser rhomboid; and if my view of the nature of the muscle is correct, brings the rhomboids (the lesser or anterior rhomboid at least, which not unfrequently extends to the occiput) into the relation with the trapezius of being segmentations or derivatives with it from one common and continuous muscular plane. The same plane is continued forwards to the ear; and variable portions are segmented from it, in front, constituting the sterno-mastoid, the cleido-mastoid, or, as in Antr, the cleido-occipital. In the last instance the segmentation has taken place further back than usual at the expense of the trapezius.

Masto-scapular (*m. s.*) in MANIS is a strap-like muscle attached to the fore part of the mastoid portion of the temporal bone, just beneath the ear, behind and external to the rectus capitis anticus major. (The sterno-mastoid has been removed so close to the skull that I cannot be sure of the relations to it.) Passing backwards it reaches the same plane with the occipito-scapular, lies in front of it and is inserted

[1] The muscle was described under this name as a variety in man by Mr Wood, *Proc. R. S.* May, 1867. Galton found it enormously developed in Dasypus sexcinctus, *Trans. Linn. Soc.* xxvi. 525.

in front of it into the spine of the scapula. Its foremost fibres run in front of the spine, beneath the trapezius, upon the fascia covering the infra spinatus.

This probably corresponds with the muscle which I have in preceding papers called cervico-humeral. I do not find it in Aï or ANTR. Like the occipito-scapular it is probably a segment of the trapezius.

Serratus magnus is in two portions passing to the two angles of the scapula as in Pteropus (Vol. III. p. 302). The anterior arises from the 1st and 2nd ribs in Aï.—In ANTR the anterior portion arises from the upper edge of the first rib, immediately behind the insertion of the scalenus. It expands and is inserted chiefly on the inner surface of the anterior angle of the scapula internal to the levator scapulæ. Its foremost fibres are quite separate from the levator. Its middle fibres are at their insertion blended with that muscle; and its hindmost fibres extend along the inner side of the base of scapula to the hinder angle where they come into contact with those of the hinder portion. This hinder portion arises from the first rib behind the preceding (separated from it by the scalenus) and from eight ribs behind the first; its fibres converge to and are inserted into the under surface of the posterior angle of the scapula. In MANIS it is too mutilated to admit of description.

Levator scapulæ in Aï arises from the transverse processes of the 8th and 9th cervical vertebræ as well as from the 6th and 7th. In ANTR it arises from the transverse cervical processes below the 1st and from anterior surface of the atlas. It is inserted into the upper part of the base of the scapula behind the serratus and distinct from it in both[1]. In ANTR the part which arises from the atlas does not become quite blended with the rest and is inserted more upon the outer surface of the upper angle of the scapula.

In MANIS it arises from the transverse processes of all the cervical vertebræ below the 2nd, and is inserted into the anterior edge of the scapula. It is apparently continuous with the

[1] Macalister did not find it distinct from the serratus in Aï, and describes the serratus as undivided.

serratus magnus and is quite separate from the occipito-scapular and the masto-scapular.

Rhomboideus, in ANTR, is one broad muscle extending from the 4th cervical spine to the 5th dorsal spine, where it comes into contact with the upper edge of the latissimus dorsi, but is distinct from it. It is inserted into the lower three-fourths of the base of the scapula, the fibres of the hinder part of the levator scapulæ passing internal to it. In MANIS it is also large, arising from three or four dorsal vertebræ and is attached to the base of the scapula behind the spine. A superficial stratum extending further back, lying between it and the latissimus dorsi, so that it is difficult to tell to which it really belongs, arises from three or four dorsal spines and is inserted on the outer surface of the hinder angle of the scapula.

More or less blending of the hinder or larger rhomboid with the fore part of the latissimus dorsi is not uncommon, and indicates a segmental relation between this rhomboid and the latissimus similar to that which I have hinted at between the occipito-scapular, the anterior rhomboid and the trapezius; and it is probable that all these muscles—occipito- and masto-scapular, rhomboideus major and minor, trapezius and latissimus dorsi—with the teres major (see teres major in Antr) are segments of one muscular plane.

Supra-spinatus and Infra-spinatus, present nothing peculiar.

Teres Minor presents nothing peculiar in Aï. In ANTR and MANIS it is pushed from its usual position on the scapula by the large teres major in the one and by the large triceps in the other, and has acquired an attachment to the spine of the scapula. In ANTR it arises from the middle of the scapular spine between the deltoid and the teres major, quite separate from both, in closer connection with the teres than with the deltoid and slightly overlapped by it. It is inserted into the outer supra condyloid ridge of the humerus just behind the hinder part of the deltoid and the supinator longus. In MANIS it arises from the anterior extremity of the scapular spine (the spine is in this animal short, the acromion part of it being as in Aï suppressed) in front of the triceps, and is inserted into a ridge on the outer side of the humerus beneath the great tubercle and the infra-spinatus.

It might be taken for part of the deltoid but is quite separate from it, and there is no other representative of the teres minor. Meckel makes no mention of it in Antr.

Subscapularis arises in Aï from the under surface of the scapula including the bony margin and the ligament of the supra-coracoid foramen and is easily divisible into three portions[1]. It lies external to the capsule of the shoulder-joint in Aï, but forms part of the wall of the joint in ANTR.

In MANIS it arises from all the internal surface of the scapula not occupied by the teres major, and passes, distinct from the capsule of the joint, to the inner tubercle. A lower portion of it, separated from the teres major by the circumflex nerve, is somewhat distinct from the rest, but not sufficiently to deserve a name.

Latissimus dorsi arises as usual in Aï, and from the dorsal (behind the 4th) and the lumbar spines, and from the hinder ribs (6th to 11th, inclusive), in ANTR. The several fibres cross, like those of the pectoral; the fibres which arise hindmost passing forwards, beneath i.e. on the axillary side of the others, to the highest part of the inner bicipital ridge of the humerus, (this is well seen in Aï where the tendon of insertion is broad and stops at this ridge); and those which arise foremost pass lowest in the arm. Some of the last in ANTR descend (constituting the *dorso-epitrochlien*) on the inner side of the arm and forearm to the wrist, being connected with the pannicle and inner condyle in their course; and in Aï some of the fibres, suddenly changing their course, descend along the inner side of the humerus and are inserted just above the inner condyle[2]. There is no attachment to the scapula. The tendon of insertion into the humerus is narrow in ANTR and passes beneath the biceps to the inner side of the pectoral crest, where it is attached close beneath the fibres of the pectoral.

In MANIS the *latissimus dorsi* arises from the hinder dorsal and the lumbar vertebræ and the ribs as far forwards as the 5th, beneath the trapezius in front, and the pannicle and brachio-

[1] The hindmost of these I conclude is the *subscapulo-humeral* described by Macalister as arising close to the glenoid cavity and inserted below the lesser humeral tuberosity.

[2] This portion is represented by Cuvier. It is said by Mr Galton (*l. c.* p. 532) to be present in Unau.

lateral muscle behind. Its costal part and the inner stratum of its lumbar fibres pass forwards—the former almost straight and the latter more obliquely—to the inner bicipital ridge of the humerus, the outermost of them becoming tendinous at some distance from the humerus. The outermost of the lumbar fibres diverge from those of the inner stratum which are ascending to the humerus and pass, on the inner side of the triceps, to the olecranon; and the foremost, or dorsal, fibres pass over the hinder angle of the scapula, without being connected with it, and run down on the inner side of the triceps and the olecranon to be continued into the portion of the flexor sublimis digitorum which passes to the large middle digit. They have no connection with the inner condyle.

These foremost fibres on their way down to the elbow and the forearm cross, nearly at a right angle, the hinder fibres which are passing forwards to the humerus. They cross external to them where they are tendinous and acquire a close connection with their tendons. Indeed they receive an accession of muscular fibres from those tendons on their way over them. So that some of the fibres passing to the forearm actually arise, at right angles or nearly so, from the tendon of insertion of the hinder portion of the muscle, and through them might be said to arise from the humerus.

The disposition of the fibres of the latissimus dorsi thus traced explains what has often puzzled me, viz. that this muscle as it passes to the humerus, not unfrequently (rat, rabbit, and others) sends from its tendon, and at right angles, what may be regarded as a second muscle, upon the inner side of the arm (it is included under the name 'dorso-epitrochlien'). It is sometimes tendinous at its origin from the lat. d., and becomes muscular as it descends the arm. Now, this muscle is clearly a representative of the anterior fibres of the lat. d. which in Manis cross the hinder fibres at right angles and derive accessory bundles from them. In Aï I have described this derivation from the lat. d. as being formed by a sudden change in the direction of its fibres.

Teres major, in Aï, is large and disposed much as in Man. In ANTR it is a very large muscle arising from the inferior costa and the greater part of the spine and part of the outer surface of the scapula; it nearly covers the infraspinatus and almost surrounds the scapular origin of the

triceps. It is inserted along the inner side of the humerus between the tubercle and the condyle. Its lower fibres are nearly parallel with those of the triceps, but pass internal to them without blending with them. A strap-like portion however passes from the angle of the scapula, with the latissimus dorsi, and is inserted, partly, into the inner side of the olecranon and, partly, along the inner side of the forearm. It may be questioned whether this appertains to the teres or to the lat. d., being closely connected with the one in its origin and with the other in its insertion. Meckel describes it as part of the teres. At any rate it acts as an extensor of the forearm. In MANIS the teres major is of moderate size, arises from the inferior costa and part of the inner surface of the scapula, internal to the triceps, and is inserted as usual into the inner bicipital ridge external to, but in close connection with, the latissimus dorsi.

Deltoid (Aï) arises from the parts into which the trapezius is inserted (see description of biceps). In ANTR the clavicular part occupies a large share of the clavicle, is separate from the scapular part, and is inserted into the pectoral crest above and in front of the origin of the supinator muscle. The scapular portion is small arising only from the acromial or fore part of the spine of the scapula and is inserted into the supra-condyloid ridge below and behind the supinator. In MANIS it does not exist at all as a distinct muscle, that which usually constitutes its fore-part being a continuation of the trapezius, and that which usually constitutes its hinder part being continued into the supinator longus.

Coraco-brachialis in Aï is a slender muscle passing from the root of the coracoid process to the inner side of the humerus, above the middle, in front of the latissimus dorsi[1]: in ANTR and MANIS I can find no trace of it[2]; and there is no distinct coracoid projection of the scapula in either.

Biceps in Aï consists of three portions. 1. 'Coracoid' portion arises, tendinous, from the foremost part of the coracoid in front of, superficial to, the deltoid, and in close con-

[1] It is said by Mr Galton to resemble this in Unau. *Trans. of Linnæan Society*, XXVI. 535.

[2] Meckel makes no mention of this muscle in his description of the Antr, and Cuvier does not represent it.

nection with it, so as to appear part of it (it is described as part of the deltoid by Meckel). It forms a long thin muscular belly which at the lower part of the arm becomes tendinous and is connected with the humeral portion, but terminates in the fascia on the ulnar side of the forearm[1]. 2. 'Glenoid' portion, from the root of the coracoid process, in front of the glenoid cavity, by a long thin tendon which passes through the shoulder-joint. It becomes muscular in the lower part of the arm and is inserted with the brachialis anticus into the ridge on the anterior and outer aspect of the ulna. It is quite separate from the other portions in its whole length. 3. 'Humeral' portion, the largest of the three, arises tendinous from the fore part of the humerus beneath the pectoralis tendon. It has a broad tendinous origin from the outer bicipital ridge and a narrow tendinous origin from the inner bicipital ridge. It therefore covers to some extent the tendon of the glenoid portion passing along the groove between the two ridges. It is inserted into the tubercle of the radius. In ANTR it consists above of one portion only which arises from the upper edge of the glenoid cavity: in the middle of the arm its muscular belly divides into two nearly equal parts, of these one terminates in a tendon which is inserted into the tubercle of the radius, and the other continues muscular joining the brachialis anticus and is inserted into the fore part of the ulna[2].

In MANIS it is a simple muscle and not large. It arises from the outer surface of the foremost part of the glenoid cup by a broad tendon which lies external to the capsule of the shoulder-joint. It soon becomes muscular in its anterior aspect; and its cylindrical muscular belly runs down to the fibrous band into which the trapezius is inserted. It here becomes tendinous and is continued under the band, internal to the brachialis anticus, and is inserted into the inner side of the anterior surface of the ulna, having no connection with the radius.

1 This portion is represented by Cuvier, but Macalister found no trace of it in the specimen dissected by him. It appears in my specimen to be the usual coracoid origin of the biceps; and its close relation to the deltoid is caused by the attachment of that muscle to the coracoid, which again is to be associated with the retirement of the acromion and the consequent connection of the rudimentary clavicle with the coracoid (p. 26).

2 The same in Dasypus sexcinctus except that it is joined by some fibres of the coraco-brachialis, which muscle is present and consists of a long and a short portion. (Galton, *loc. cit.* p. 536.)

Brachialis anticus in Aï arises from the anterior and outer aspect of the humerus, beneath the deltoid, joins the glenoid part of the biceps, being placed on the radial side of it, and is inserted into the ulna a little above and radial of it. In ANTR it passes from beneath the deltoid ridge of the humerus to the ulna joining the ulnar part of the biceps.

In MANIS it is large in comparison with the biceps, arises from the anterior and outer surface of the humerus beneath and external to the pectoral crest, and is inserted into the anterior and inner surface of the ulna, lying on the radial side of the biceps and so separating it from the radius.

The disposition of the biceps in these animals derives interest from its variety. In MANIS it is single in its whole length. In the ANTR it presents a less simple form; for though single above it bifurcates below to the radius and ulna. In Aï it consists of three parts which are separate, or nearly separate, in the whole length: the 'coracoid' and 'humeral' parts correspond with that which is usually attached to the coracoid only, and the 'glenoid' part furnishes an exception to the general rule by being inserted into the ulna only. The brachialis anticus is steady in its adherence to the ulna and to the part of the biceps which is attached to the ulna. It will be remarked that in Manis neither muscle is attached to the radius.

Triceps presents nothing peculiar in Aï. In ANTR it is very small, the origin of its scapular part being confined to the immediate vicinity of the glenoid cavity and of the humeral parts to the lower half of the humerus. In MANIS its scapular portion is very large. It arises not only from the whole length of the inferior costa of the scapula; but a thick outer stratum is prolonged over the supra-spinatus and is attached along the entire length of the spine of the scapula beneath the supinator longus. It arises also from the back of the humerus being prolonged, externally, to the outer tubercle; but the internal humeral portion (that beneath and internal to the radial nerve) is small. It is inserted into the olecranon: the part which arises from the spine of the scapula being inserted on the outer or radial side of the olecranon, that from the inferior costa of the scapula and the back of the humerus into the upper surface of the process, while the latissimus dorsi is attached to the inner side.

Anconeus internus[1] is distinct in Aï and ANTR and large in MANIS. It is nearly square, passes transversely across from the back of the inner condyle, over the ulnar nerve, to the inner side of the olecranon. In ANTR it is confined to the upper part of the condyle; but in MANIS it covers the lower as well as the upper part of the back of the condyle.

Anconeus externus distinct in Aï. In ANTR it extends down nearly the whole length of the outer surface of the ulna between the extensor carpi ulnaris, on its outer side, and the flex digitorum and flex carpi ulnaris which arise from the ulna on its inner side; and the three muscles may be said to form an almost continuous sheet in these animals. In MANIS it is large, but simply passes from the upper surface of the back of the outer condyle to the outer surface of the olecranon.

The disposition of the muscles on the surface of the palmar aspect of the forearm in UNAU and ANTR is remarkable. In each the supinator longus and the flexor carpi ulnaris consist of a superficial and a deep portion; and the superficial portions of the two muscles meet in the middle and are forcible reminders of the gastrocnemius. The deeper portion of the fl. c. u. evidently corresponds with the soleus.

Supinator longus in these, as in most animals, is a flexor of the forearm. In UNAU and Aï it consists of two parts, of which one arises, flat and muscular, high up from the outer side of the humerus and expands upon the fascia of the palmar aspect of the forearm, extending to the wrist. The other and deeper part arises from the humerus, beneath the preceding, and is inserted into the outer border of the radius a little above the carpus, thus resembling the sup. l. of man. In ANTR the disposition is much the same, the superficial part arising from the humerus between the insertions of the clavicular and scapular portions of the deltoid and being inserted into the palmar fascia and the supernumerary bone on the inner side of the carpus. The deeper portion arises lower down, and is inserted into the radius just above the carpus.[2]

[1] This muscle, which is merely a part separated from the inner origin of the triceps, is by no means uncommon. It is called *Epitrochleo-anconeus* by Prof. Gruber, *Mém. de l'Acad. des Sc. St Pétersbourg*, 7th Sec. tome x. No. 5, and *Bulletin de l'Acad.* Mélanges biologiques, VI. 464.

[2] The supinator longus appears to be absent in Dasypus sexcintus, Galton,

In MANIS it is single, arises, broad and musculo-tendinous, from the whole of the lower edge of the spine of the scapula (having that is the usual origin of a part of the deltoid), passes over the humerus and elbow and descends along the outer side of the forearm in the usual course of the sup. l. and is inserted into the outer edge of the radius just above the wrist. (Pl. IV. fig. 1, *Sup. l.*)

Although the sup. l. usually arises from the humerus near the insertion of the deltoid, and in Antr arises between the insertions of the two portions of the deltoid, yet the fusion of the two muscles, as presented in Manis, is very rare. I do not know any other instance of it. It is of great interest, and may throw some light upon the serial homology of the muscle respecting which there is much difficulty. It seems to indicate a relation of this kind to the sartorius. Yet, as I have stated above, the disposition of the superficial part of the muscle in the other three animals is suggestive of homology with the inner (tibial) head of the gastrocnemius.

Supinator brevis large in all. In ANTR it descends nearly to the lower end of the radius. In MANIS also it is inserted along nearly the whole length of the anterior edge of the radius; and it contains a rather large sesamoid bone in its tendon of origin. This sesamoid has a concave under edge applied upon a facet on the outer surface of the capitulum of the radius and a smaller concave upper surface which is applied upon the edge of the outer condyle of the humerus. The tendon of origin of the superjacent extensor digitorum is quite free from it.[1]

Pronator teres is large and descends low in all. In UNAU and Aï its origin is from a little above the int. cond. of the humerus on the same plane with the fl. c. u. and the fl. c. r. In ANTR its origin extends very little above the int. cond., and is covered by the superficial part of the fl. c. u. In all, its insertion extends nearly to the lower end of the radius opposite the insertion of the deeper portion of the sup. l. In MANIS it is large, arises from the inner condyle, above and in front of the flexor digitorum, and is inserted into the inner surface

l. c. p. 540; and I do not find it in Cuvier's representation of the Tatou. It is well developed in Tamandua and Orycteropus.

[1] Owen, *Comp. Anat.* II. 409, mentions an articular sesamoid developed on the outer side of the capsule uniting the radius with the humerus. Mr Macalister found a sesamoid bone in the tendon of the supinator brevis of a woman. *Jour. Anat.* III. 108.

of the anterior edge of the lower half of the radius, extending close to the wrist.

Pronator quadratus in UNAU and Aï is much as usual, though in both small in proportion to the length of the fore-arm, but not so small in Aï as Meckel describes. The attachment to the radius is broader than that to the ulna; so that the fibres radiate somewhat from the ulna to the radius. In ANTR it covers nearly the whole interosseous space, the upper fibres being nearly transverse, the lower descending more obliquely from the ulna to the radius. The lowest part of all is, to some extent, separate from the rest, forming a pyramidal muscle with a muscular base attached to the ulna, and a tendinous apex attached to the margin of the radius just above the interval between the scaphoid and lunar bones[1]. In MANIS there is no trace of it.

Flexor carpi ulnaris in UNAU is in two parts; one arising from the inner condyle of the humerus and expanding upon the fascia on the inner side of the forearm, where it meets and joins the sup. l. and is inserted into the margin of the ulna, the pisiform bone and the palmar fascia. The deeper part arises from the inner edge of the ulna between the flex. dig. and the ext. c. u., from the inner side of the olecranon, and by a thin aponeurosis from the internal condyle, and is inserted into the pisiform bone beneath the preceding. The ulnar nerve lies between the two. In ANTR the disposition is similar, except that the segment of the superficial portion passing to the palm, and attached to the pisiform bone the pad and the flexor sheath, is more separate from that passing to the pisiform bone only, and bears, therefore, closer resemblance to a palmaris longus; and the deeper portion arises from the lower part of the ulna only, being separated from the superficial part by the flexor dig., and is inserted beneath it into the pisiform bone. In Aï the distinction between the ulnar and the humeral parts is not greater than in man. The tendon passes over the proximal part of the pisiform which is smooth and is inserted into the distal part and into metacarpals IV. and V.

[1] In the Scinc (*Cyclodus nigroluteus*) I find a portion which resembles this separate portion passing over the wrist joint and inserted into the lunar part of the scapho-lunar bone. Meckel does not mention the muscle in Antr.

In MANIS the muscle is quite dwarfed by the inordinate development of the flexors of the digits. It lies beneath and between the portions of flex. dig. s. to digits IV. and V., and arises in company with them from the olecranon and the surface of the flex. dig. p. It is very small and short, and is inserted into Met. IV. The pisiform bone which is small appears merely as a sesamoid developed in it.

This in Manis corresponds with what I have described in the others as the ulnar or deeper portion of the muscle. The more superficial part would seem to be absorbed by the flex. dig. s.

Flexor carpi radialis passes from the inner condyle in all. In UNAU it is inserted into the projecting process of the scaphoid which forms the inner edge of the carpus. (The palmaris l. is inserted into the corresponding process in Aï.) In Aï it is inserted into the root of the rudimentary Met. I. This gives it greater purchase than if it had been inserted into Met. II. In ANTR it is inserted into the base of Met. II. In MANIS it passes over the projecting inner edge of the scapho-lunar bone along the bases of Met. I, II. having some fibres attached to these, and is inserted into the palmar surface of the base of Met. III. This extension of the tendon across to the middle of the palm resembles that so usual of the peroneus longus, in an opposite direction, across the sole.

The *Palmaris longus* and *Flexores digitorum* are involved and related in peculiar and instructive varieties. In UNAU a muscle, representing chiefly the *palm. l.* and partly the *flex. dig. sublimis,* arises from the int. cond. of the humerus, between fl. c. r., and u. It terminates in a tendon which divides into two; and these are lost in the flexor sheaths of the two digits. A much smaller muscle is detached from the surface of the fl. dig. and gives off two delicate tendons which join the under surface of the two tendons just mentioned over the metacarpo-phalangeal joints. This is a partial representative of the *flexor dig. sublimis.* The *Fl. dig. prof.* is large, arises from the internal condyle and from the under surface of the combined tendons of fl. c. r. and u. and palm. l., also from the surface of the radius and ulna, and gives rise to the two flexor tendons which pass to the terminal phalanges of the two digits.—In Aï

the *Palmaris l.* arises from the int. condyle in company with the pronator teres, fl. c. r. and fl. c. u., being situated between pr. t. and fl. c. r., and is inserted into the process of the scaphoid that descends towards Met. I. It meets and is closely connected with the superficial part of the sup. l. in the middle of the fore-arm, and in its insertion resembles that of sup. l. in Antr[1]. The *flexor digitorum* arises from the internal condyle beneath the other muscles (pr. t., palm. l., fl. c. r. and u.) and from the radius and ulna. The part arising from the radius is large, and the two tendons to digits II. and III. are derived chiefly from it. The tendon to digit IV. is derived from the ulnar part of the muscle. Of the humeral part some of the muscular fibres blend with those of the ulnar part and so terminate in the tendon to digit IV.: the remaining and larger portion of it gives rise to two tendons which lie upon and subsequently join the two tendons to digits II. and III. This humeral part is, therefore, evidently the representative of the *flexor dig. subl.*—In ANTR the *Palmaris longus* is not distinctly segmented from the flexor carpi ulnaris. The *Flexor digitorum sublimis* consists of two parts; one arising from the internal condyle separate from the fl. d. pr. and passing to digit II.; and another also arising from the int. cond., but closely connected with fl. d. pr. so as to appear to be derived from it. The latter is the smaller and passes to digit III. Both are partly blended with the flexor sheaths and partly related to the flexor tendons after the usual manner of the fl. d. s. The *Flexor digitorum profundus* is very large, arising from the int. cond., the radius and the ulna. It extends to the back of the ulna between the two parts of the fl. c. u. and has extensive origin from both sides of the olecranon. It gives rise to two tendons of very unequal size, the smaller to digit II. and the larger to digit III.

In each instance that which represents the flexor dig. subl. is imperfectly segmented from the fl. dig. pr., and the degrees and varieties of segmentation are noteworthy. Moreover in UNAU it is only imperfectly segmented from the palmaris. In ANTR the palmaris is imperfectly segmented from the fl. c. u.; and in AÏ the disposition of the palmaris is peculiar, for it has no connection with the fascia or flexor sheaths of the palm.

[1] Prof. Macalister found it inserted into the palmar fascia and the pisiform and unciform bones. It is quite to be expected that varieties of this muscle would occur in animals of the same species.

In MANIS there is no *Palmaris longus*. The *Flexor digitorum sublimis* (Pl. III. fig. 2) is disposed in a remarkable and unusual manner, and consists of five separate portions, i.e. one for each digit including the pollex. The division for the pollex is quite superficial, and arises, muscular, from the fascia at the lower part of the forearm. It soon bifurcates and its divisions, passing on the sides of the long flexor tendon, are inserted into the sides of the first phalanx. The division to digit II. arises, in conjunction with the deep flexor, from the inner condyle of the humerus, separates from the deep flexor in the middle of the forearm and, after being closely connected with the flexor sheath, passes internal to it, splits and is inserted into the sides of the second phalanx. The division to digit III. derives its origin partly from the continuation of the latissimus dorsi (see description of that muscle) and partly from the inner condyle of the humerus. The divisions to digits IV. and V. arise together and in company with the fl. c. u. from the olecranon and the surface of the deep flexor. They separate from it and from one another and from the flexor carpi ulnaris as they descend to the wrist. The tendon to digit IV. is disposed in the same manner as those to digits II. and III.; but the tendon to digit V. passes external to the flexor sheath, on the ulnar side, and is inserted into the ulnar side of the second phalanx.

The muscle in this instance, therefore, is connected with the internal condyle, the olecranon, the deep flexor, the flexor carpi ulnaris, and contains the palmaris longus. I cannot recall any other instance in which the pollex has so complete a representative of the superficial flexor muscle. This digit has in addition a flexor longus and a flexor brevis.

The passage of the flexor sublimis to the ulnar side only of digit V. is unusual; when the tendon to this digit is, as is not unfrequently the case, single it commonly is inserted on the radial side[1].

The *Flexor digitorum profundus* in MANIS is of great size and has much the same relations as in Antr. It arises from the inner condyle of the humerus and the entire palmar surfaces of the radius and ulna and from the back part and both sides of the olecranon. It contains a large sesamoid as it passes over the wrist, which plays upon a convex cartilaginous

[1] See note of the same peculiarity in fl. br. dig. in hind limb.

surface of the scapho-lunar bone. It gives off a tendon to each digit.

Lumbricales. In UNAU one passes from the radial side of each deep flexor tendon to the radial side of each digit. They send slips to the sides of the phalanges, but the larger parts are connected with the extensor tendons. I do not find them in AÏ or ANTR[1]. In MANIS they are four, passing from the sesamoid mass, between the tendons, to the radial sides of the second phalanges of the four outer digits. They are inserted into the phalanges and do not therefore reach the extensor tendons.

Extensor carpi radialis (UNAU and AÏ) is one strong muscle arising from the outer condyle. Over the wrist its tendon divides into two. Of these one, small, is inserted into the middle of the back of Met. II. near the proximal end; the other and larger is inserted into the corresponding part of Met. III. In ANTR it is described by Meckel to be disposed in the same way; but in my specimen the tendon does not divide but passes between the two metacarpals, and is inserted into the radial side of Met. III. just below its upper end. In *Manis* it arises broad from the outer condyle and the ridge ascending from it and is, in consequence of the peculiar origin of the supinator longus, the uppermost muscle arising from that ridge. It terminates in one strong tendon which is inserted into the distal end of Met. III., some of the fibres passing on to the proximal end of the first phalanx.

This muscle not unfrequently presents one or other of the dispositions described in these animals. When there is one tendon only it is inserted into Met. III., and when there are two tendons or two muscles, the larger of the two is inserted into Met. III., showing this to be the primary or more important insertion, that into Met. II. being secondary or subsidiary.

Extensor carpi ulnaris (UNAU) from the outer condyle and the side of the olecranon and ulna, gives rise to two tendons of which the one, derived chiefly from the condyloid part, is inserted into the back of the proximal end of the first phalanx of digit III.; the other is inserted into the ulnar edge of the base

[1] Cuvier does not represent them, nor does Meckel mention them, and Prof. Macalister notes their absence in Aï. Yet they are present in the hind limb in Antr.

of Met. IV. In Aï there are two muscles, one arising tendinous from the outer condyle and inserted into the back of the distal part of Met. IV: the other has a slight tendinous connection with the condyle, but arises chiefly from the outer side of the ulna, keeps close to that bone, and is inserted into the ulnar side of the base of Met. V. In ANTR there are two distinct muscles arising from the outer condyle: one of these which has also a slight attachment to the ulna is inserted into the rudimentary Met. V., sending a delicate slip to Met. IV.; the other and larger is inserted into the ulnar side of Met. III. In MANIS it consists also of two muscles. Of these the smaller and more external arises from the outer condyle, the olecranon and the edge of the ulna, passes over the groove in the outer surface of the lower edge of the ulna on to the outer and palmar surface of the wrist and is inserted into the palmar surface of MET. V. The inner and larger muscle arises from the outer condyle between the preceding and the extensor digitorum and divides a little above the wrist into two broad tendons; the outer and smaller of these is inserted into the outer side of Met. V., and the inner is continued along the outer side of digit IV. to the terminal phalanx.

The divisions of this muscle in the four animals show an interesting similarity to the usual divisions of the peronei in the hind limb with which it is no doubt homologous. The outer part of it (the extensor carpi ulnaris proper) corresponds with the peroneus longus. It passes in Manis on to the palmar aspect of Met. V., which corresponds with the partial insertion of the per. l. into the plantar aspect of Met. V. The next portion, inserted into the outer side of the base of Met. V., probably corresponds with the peroneus brevis; and the inner or third portion corresponds with the peroneus tertius. This will be seen to tally closely with the arrangement of the parts in the hind limb. There is a good deal of variety in the muscles in both limbs in different animals, especially in the peroneus brevis and tertius, though the peroneus longus is remarkably constant in its partial or entire insertion into the innermost metatarsal[1]. In the fore-limb the three muscles are, in several animals, blended into one—the extensor carpi ulnaris. In others there are two—the extensor carpi ulnaris, constituting the homologue of the peroneus brevis and longus, and the extensor minimi digiti, which may pass to two or more digits, constituting the homologue of the peroneus tertius. All these, together with the extensor digitorum, belong to what I describe as the 'superficial layer.' (See pages 48 and 69 to 73.)

[1] See exception to this in Aï (p. 75).

Extensor digitorum (UNAU) from the outer condyle to the terminal phalanges of digits II. and III. In Aï it is small, and passes to the terminal phalanges of II, III, and IV. In ANTR it arises from the outer condyle and slightly from the ulna, being situated rather deeply. It passes as a single tendon through a tendinous loop close to the carpus and runs to the ungual phalanx of digit III, not stopping, as Meckel describes it to do, at the first joint.

In MANIS it arises from the outer condyle of the humerus and the upper third of the ulna. As it descends it divides into two large portions (Pl. IV. figs. 1 and 2) of which the tendons pass to the terminal phalanges of digits III. and IV, and two smaller portions: of these one (3) from between the two large portions passes along the ulnar side of digit III. to the terminal phalanx, and the other (4) from the ulnar or lowest part of the muscle, sends a tendon to the terminal phalanx of digit V, and a small tendon which crosses to beneath the large tendon to digit IV, and runs under that tendon to the terminal phalanx. They are all thrown into relief by fibro-cartilaginous sesamoid bodies upon the metacarpo-phalangeal and phalangeal joints of the digits.

I conceive that the larger portions of the muscle in Manis are representatives of the 'superficial layer' (*i. e.* of the extensor digitorum), the smaller portions are, together with the ext. poll. pr. the representatives of the 'deep layer' (including the extensor brevis) of the three other animals.

Extensor brevis digitorum is well developed in all three animals and corresponds closely with the extensor brevis digitorum pedis. In UNAU it arises from the back of Mets. II. and III. embracing the tendons of ext. c. r, and also from the back of the carpus beneath the tendon of ext. dig. It has two tendons of which the inner or radial, uniting with the palmar interosseus from between Mets. II. and III, joins the ulnar side of the tendon of ext. dig. to digit II, and so reaches the terminal phalanx of this digit. The other is lost upon the dorsal surface of the proximal end of the second phalanx of digit III. In Aï it arises also from the back of the carpus and metacarpus. The muscular fibres are continued over the first phalanges; and the three tendons arising from them constitute the chief part of,

[While this sheet is passing through the press I take the opportunity of referring to a paper by Mr Galton in the *Annals and Magazine of Natural History* for Oct. 1869, on the TWO-TOED ANTEATER, just received from the Author.]

rather than the accessories to, the extensor tendons. Each is joined by an interosseus on either side. In ANTR it consists of two portions. Of these one arises from the lower end of the ulna, passes over Met. II, and extends to the ungual phalanx constituting the only extensor of digit II. The other and larger part arises tendinous from the carpus close to the loop for the tendon of extensor dig., and applies itself to the under part, and both sides of the extensor tendon to digit III. In MANIS (see ext. dig.) the arrangement is different.

This muscle, which is well developed in the first three animals[1], represents very clearly the extensor brevis digitorum pedis, and is a reappearance of a disposition not uncommon in amphibious reptiles. The portion passing to digit II. in Antr represents the extensor indicis. It reminds us of a corresponding portion in the hind limb of Manis (p. 69).

Extensor pollicis primus (UNAU) from the hinder surface of the ulna, in nearly its whole length, to the inner edge of the trapezium, (Aï) from the ulna, in a somewhat more limited range, to the hinder surface of the base of the rudimentary pollex, i.e. to the trapezium. In the ANTR it arises, which is very unusual, from the outer condyle, and from it only, by a broad thin tendon between the fl. c. r. and the fl. digit., and extending up beneath the latter. It passes, as usual, over the fl. c. r., and is inserted into the bone rudimentary of trapezium and others.

In MANIS it arises from the upper half of the ulna, beneath the origin of the extensor digitorum, crosses over the lower end of the radius and is inserted into the inner edge of the trapezium. On the wrist it sends a thin slip to the inner side of the extensor surface of digit I, which reaches the terminal phalanx.

I think that the muscles on the dorsal or extensor surface of the forearm may, like those of the corresponding surface of the leg, be divided into two planes, a superficial, nearly vertical, constituting what is usually described as the extensor digitorum with the extensor carpi ulnaris and the extensor minimi digiti, and a deeper plane crossing obliquely from the ulnar to the radial side, and consisting of the muscle which from human anatomy is called extensor ossis metacarpi pollicis (better called 'ext. poll. primus' or, better still, 'rotator carpi'), the other extensors of the pollex and the extensor indicis. In the fore-limb, owing probably to the greater variety of

[1] It is described by Meckel in Aï and Antr.

movement and the consequent greater specialization of the part, the arrangement is less clear, and the division of the planes is less complete than in the hind limb; and the segments of the deeper layer are often, some of them at least, absent though the rotator carpi is very constant (see p. 69 et seq.).

Extensor indicis (UNAU and AÏ) from the middle of the ulna, external to the preceding, to the base and upper surface of the stunted first phalanx of dig. II. In ANTR see p. 48.

The representative of this muscle in MANIS (ext. i.) arises from the lower half of the ulna, crosses beneath and in the same channel with the extensor digitorum, and divides into tendons which pass to the radial side of digit III, to the middle of digit II. and to the ulnar side of digit I, all reaching the terminal phalanges.

Interossei (UNAU): one between rudimentary Met. I. and Met. II. passes to the radial side of the extensor tendon of digit II: one between rudimentary Met. IV. and Met. III. to the ulnar side of the extensor tendon of digit III; this takes origin also from the unciform and pisiform bones: one between Mets. II. and III, on the palmar aspect, which passes to the ulnar side of the extensor tendon of digit II; and one on the dorsal aspect to the radial side of the extensor tendon of digit III. There are thus four interossei, one on each side of each extensor tendon. There is also an adductor of digit II. passing from the pisiform bone to the ulnar side of the first phalanx.

It is interesting to observe that even here the interossei follow the general plan. There is only one digit that can be adducted to the line drawn through digit III, and the muscle (or muscles) which effects this movement is situated palmad of those which act as abductors from the same line.

There is also a second set of interossei '*phalangeal interossei*' two in number quite separate from the preceding, arising from the apposed sides of the two second phalanges and joining the apposed sides of the two extensor tendons near their insertion into the ungual phalanges.

These phalangeal interossei have relation to the close approximation and lateral immobility of the phalanges which in this respect closely resemble ordinary metacarpals.

In Aï the arrangement is much the same as in UNAU, there being an interosseous on the radial side of Met. II. and one on the ulnar side of Met. IV; two in each of the metacarpo-phalangeal interspaces between digits II. and III, and III. and IV. These are chiefly situated on the back, but extend also into the palmar part of the space between the metacarpals. They pass to the apposed sides of the respective digits. Their origins extend to the phalanges. Indeed they may be said to be phalangeal rather than metacarpal interossei. The three sets of muscles—flexor brevis, metacarpal and phalangeal interossei—are less distinguishable from one another than in Unau, the metacarpal parts being more blended with the phalangeal parts on the one hand and with the extensor brevis on the other.

In ANTR the interossei lie on either side of digit III. Several small muscles connected with the pisiform bone are described by Meckel, *Archiv*, V. 47.

In MANIS the small muscles on the palmar surface are as follows. *Abductor pollicis* arises from the sheath of the flexor carpi radialis, over the scapho-lunar bone, and is inserted into the radial side of the first phalanx. *Flexor brevis pollicis* arises, in close contact with the preceding, from the sheath of fl. c. r. and is inserted into the radial side of the sesamoid bone over the metacarpo-phalangeal joint. It represents therefore the inner part of the flexor brevis; and there is no outer part present. Four adductors towards digit III. arise and radiate from the middle of the scapho-lunar bone and are inserted into the ulnar sides of the sesamoid bodies and first phalanges of digit I. (this is *adductor pollicis*) and digit II, and the radial sides of the sesamoid bodies and first phalanges of digits IV. and V. (these are the palmar *interossei*). Their connection with the sesamoid bodies is very slight. None of them pass beyond the phalanges. The origin of the adductor of digit II. is continued from the scapho-lunar bone along Met. IV, and is derived partly from the first phalanx of digit IV. It, therefore, crosses over Met. III; that is to say, it has an origin similar to that commonly given to the adductor pollicis. The part nearest the phalanges is somewhat separate from the remainder, and constitutes a *transversus* muscle.

The *abductor* and *flexor brevis minimi digiti* are very small,

especially the latter. This (the fl. br.) arises from the metacarpal, and is inserted into the sesamoid body and the base of the phalanx. The *abductor* arises from the back and outer part of the unciform and the base of the metacarpal, and is inserted into the side of the first phalanx.

The *dorsal interossei* are on both sides of the three middle digits, and all pass to the sesamoid substances on the terminal joints and to the terminal phalanges close to, but not directly connected with, the extensor tendons. The first, arising from Mets. I. and II, passes to the radial side of digit II. In the interspace between Mets. II. and III. there are two interossei—one large arising from both metacarpals and passing to the radial side of digit III. and one small arising, beneath the other, from Met. II. and passing to the ulnar side of digit II. In the interspace between Mets. III. and IV. there are two interossei of nearly equal size arising from the respective metacarpals and passing to the respective digits. In the interval between Mets. IV. and V. there is only one muscle arising from both metacarpals and passing to the first phalanx only of digit IV. and to the sesamoid body on the palmar aspect of its metacarpo-phalangeal joint.

HIND-LIMB.

Psoas parvus and *magnus* and *Iliacus* present nothing peculiar except that the insertion of the two latter extends to a considerable distance down the femur, especially in ANTR; and in this animal the iliacus extends a little on to the outer surface of the spine of the ilium encroaching somewhat upon the territory of the glutæus medius with which it is there closely connected. In MANIS the *iliacus*, which is quite confined to the inner surface of the ilium, is inserted more than half-way down the femur, the *psoas magnus* presents nothing peculiar, and the *psoas parvus* is a powerful muscle.

Glutæus Magnus (Aï) arises, as usual, from the back of the iliac crest and from the sacral and caudal spines, and is inserted into the femur below the outer trochanter and also into the fascia, its fibres meeting those of the pannicle. Its hindmost fibres are in close contact with those of the semitend. and add.

m. In ANTR it arises from the crest of the ilium, the sacral spines and two of the caudal transverse processes, the fibres from the latter emerging from beneath the caudal muscles, and is inserted into the lower half[1] of the outer side of the femur close to the vast. ext. In MANIS it is a very broad muscle arising, in front, from the short thick anterior crest of the ilium and by the lumbar fascia from the hindmost one or two lumbar vertebræ. It is here, by its anterior edge, in contact with the external oblique and, by its inner surface, applied upon the internal oblique. It arises also by fascia covering the caudal muscles from the sacral spines and one or two anterior caudal vertebræ. It covers the whole of the outer aspect of the buttock and thigh and is divisible into three portions. Of these the foremost (Pl. IV. fig. Gl. 1), representing probably the sartorius and tensor vaginæ femoris, passes over the patella and is lost there; the middle and broadest (Gl. 2) passes by a tendinous expansion, over the outer side of the knee, to the edge of the tibia external to the tendo-patellæ; and the hindmost portion (Gl. 3) is inserted into the femur just above the outer condyle.

The anatomy of the *Glutæus magnus* in these animals is confirmatory of the view expressed in the preceding Vol. of this *Journal*, p. 333, that this muscle is the serial homologue of the latissimus dorsi with probably the teres major. Its origin from the sacral and caudal vertebræ, its insertion into the fibular side of the femur, it may be as low as the fibular condyle, its frequent extension upon the fibular side of the leg even to the ankle, harmonize with the origin of the latissimus dorsi from the dorsal and lumbar spines with its insertion into the ulnar side of the humerus, it may be as low as the ulnar condyle, and its frequent extension down the ulnar side of the forearm even to the wrist.

Glutæus medius, minimus, and *Pyriformis,* not separable from one another in Aï or ANTR, form a large muscle arising from the outer surface of the ilium, from the margin of the sacrum and from the transverse processes of the two foremost caudal vertebræ and inserted into the outer and fore part of the trochanter[2]. In Manis a broad thick muscle arises from the

[1] Not in the whole length as Meckel describes it to be.

[2] The gl. med. and pyriformis are represented separate in both animals by Cuvier, but I cannot make any clear divison between them. The tendon of the hinder portion is somewhat separate from the rest near the trochanter in Antr, but that is all.

outer surface of the ilium, the edge of the sacrum and the first caudal transverse process, especially from the under surface of the last. It is inserted into the fore, upper and hinder surface of the great trochanter presenting no distinct division into Gl. med., min., and Pyriformis.

Gemelli form one muscle in Aï and ANTR with the sciatic nerve passing between it and the preceding; the *Obturator internus* and the *Quadratus femoris*, if they exist, which is not clear, being united with them. In MANIS the same as in the other two.

Obturator externus large in Aï and ANTR. In MANIS it is not quite so large or so separate from the preceding muscle as it is in Aï and Antr.

Tensor vaginæ femoris (UNAU and Aï) from the outer part of the ant. sup. spine of the ilium, broad and flat, to the outer and fore part of the femur beneath the great trochanter, its fibres meeting those of the glutæus max. It has all the appearance of being a segmentation from this muscle. No distinct trace of it in ANTR. In *Manis* it is blended with the glutæus, forming one muscle with it and the sartorius.

Pectineus and *Adductor brevis* large in all three and having, especially the pectineus, extensive attachment to the femur. They are inserted, in the Sloths, into the hinder and outer aspect of the femur. In MANIS they are not so large: the pectineus arises from the pubes at the inner side of the insertion of the psoas parvus and is inserted into the middle third of the back of the shaft of the femur: the Adductor brevis arises from the under surface of the pubes, internal to the preceding, and is inserted into the back of the femur above it.

Adductor longus (UNAU and Aï) has broad origin from the margin of the pubes external to the symphysis. In UNAU it terminates in a narrow tendon which passes in front of the femoral vessels and is inserted into the inner side of the femur, just above the condyle. In Aï it divides into two; a long narrow portion which corresponds with that in Unau, passing in front of the femoral vessels to above the inner condyle; and a broader portion, passing behind the femoral vessels to the hinder and outer aspect of the lower part of the femur. In ANTR the disposition is much as in Aï except that its origin does not

extend so far outwards upon the pubes. In MANIS it arises from the surface of the pubes under cover of the gracilis and is inserted into the inner and back part of the lower end of the shaft of the femur. It is divisible into two parts, one situated behind the other but nearly parallel with it; and both run in front of the femoral vessels.

Adductor magnus is comparatively small in all. In UNAU it arises from the tuber ischii, external to and closely connected with the semi-membranosus and semi-tendinosus, passes internal to and in front of the femoral vessels, like the add. l., and is inserted into the back of the femur above the internal condyle, external to and beneath the insertion of the add. l. In AÏ its origin from the tuber ischii is in close connection with that of the biceps. It is inserted chiefly into the back of the femur external to the hinder portion of the add. l.; but a tendon from it passes in front of the femoral vessels and is inserted, with the anterior portion of the add. l., just above the internal condyle. The femoral vessels, therefore, perforate the two muscles in this animal much as they do in man; but the portions of the two muscles between which they pass are more separate than they are in him. In ANTR it is a strap-like muscle arising from the tuber ischii by a tendon common to it with the biceps. It passes, as in Unau, entirely in front of the femoral vessels, and is inserted behind and a little below the anterior part of the add. l. In MANIS it consists of two portions arising from the tuber ischii—one (Pl. IV. fig. 4, *Ad. m.*) thick, arising between the adductor l. and the semi-membranosus, in close connection with the latter, and inserted into the inner side of the inner condyle of the femur. The second portion (*Ad. m.'*) is smaller, arises with the biceps or rather from the tendon of origin of the biceps and is inserted into the popliteal aspect of the inner condyle of the femur between the last portion and the inner head of the gastrocnemius, which latter derives some fibres of origin from it. Both portions, therefore, like those of the add. l., pass in front of the femoral artery.

Sartorius (UNAU) is a large muscle arising from the spine and adjacent inner surface of the ilium, where its fibres are closely connected with those of the iliacus internus. It is inserted into inner side of the femur between the vast. int.

and the add. l. In Aï it arises from the spine of the ilium; its tendinous fibres appearing, to some extent, continuous with those of the external oblique[1]. It is inserted, as in Unau, into the lower part of the inner side of the femur, but its insertion extends also upon the inner side of the upper part of the tibia. In ANTR it arises from the inner surface of the crest of the ilium a little behind the spine of the ilium, in close connection with the iliacus internus and from the fascia upon that muscle, and is inserted into the inner side of the tibia only. In MANIS it may be regarded as forming part of the glutæus, arising between it and the external oblique (which does not extend to the ilium) from the anterior surface of the ilium and the lumbar fascia, and is inserted into the anterior surface of the patella.

Thus the disposition of the muscle is different in all four. Below, it is inserted into the femur in one, into the tibia in another, into both in a third, and into the patella in the fourth. Above, it is connected with the external oblique in one, with the iliacus in two[2], and with the glutæus magnus and the external oblique in the fourth. It may be remarked that as the fascia of the thigh is indistinct near the abdomen in these and many other animals, there is no clear representative of Poupart's ligament: the abdominal muscles are inserted into the linea ilio-pectinea and the spine and symphysis of the pubes; and between these and the spine of the ilium they are, to some extent, connected with the tissue or fascia upon the iliacus. Thus the origin of the sartorius may extend, as in Aï, from the spine of the ilium in the direction of the external oblique or, as in Unau and Aï and as it more frequently does, in that of the iliacus or, as in Manis, in the direction of the glutæus.

In MANIS indeed, it appears to be a part of the glutæus, and unites that muscle with the external oblique; and one would be disposed to look upon this as its true position, and to regard it to be, as well as the tensor vaginæ femoris, a segment of the glutæus; yet in ANTR where, as in most of the higher mammals it extends to the tibia only, it has no relation with the glutæus or external oblique, and is placed upon the inner surface of the ilium in close connection with the iliacus muscle. These animals, in short, illustrate well the shifting relations of the muscle above and below. Its origin in

[1] Meckel describes it as arising not from the ilium but from the external oblique. It must be remembered, however, that the lowest fibres of the external oblique arise from the spine of the ilium.

[2] Galton found it in Dasypus arising from the outer edge of the psoas parvus. In Orycteropus (Vol. II. of this *Journal*, p. 311) I found it extending, over the iliacus, as high as the rib.

Manis squares well with the suggestion I have made (p. 40) of its being the homologue of the upper part of the supinator longus in that animal.

Quadriceps extensor cruris presents nothing peculiar in any.

Gracilis (Unau and Aï) has a broad origin (Pl. II. *Gr.*) from the symphysis and adjacent fore part of the pubes and divides into two portions, of which one (*Gr.'*), arising more externally, is inserted into the inner side of the tibia as usual, and the other (*Gr.''*), arising nearest to the symphysis, crossing over the back of the leg to the outer side, joins the lower edge of the ischial part of the biceps, and is inserted into the fibula and the fascia on the fibular side of the leg[1]. In Unau the insertion of the inner portion is confined to the upper part of the tibia; but in Aï it extends to the inner ankle and expands upon the back of the leg, joining the femoral part of the biceps, and forming with it a sheath over the gastrocnemius, which, in the upper part, is muscular, but below, is tendinous, and is lost upon the heel. Above, in Aï, the gracilis and the external oblique are so closely united at the linea ilio-pectinea that their tendons appear to be continuous. In Antr the gracilis has a very broad origin from the symphysis and adjacent region of the pubes, concealing the adductors and flexors, and is inserted into the inner side of the tibia and the fascia of the leg, extending to the ankle and heel. In Manis the origin is confined to the symphysis and adjacent parts of the ramus and body of the pubes. It preserves a uniform width and is inserted on the inner side of the shaft of the tibia.

Biceps consists of two parts—an ischial and a femoral part—in all four. The ischial part presents nothing peculiar: it arises in Antr from the tuber ischii being covered by the semitendinosus. The femoral part, in Antr, arises from the outer and lower part of the hinder surface of the femur, below the insertion of the glutæus and also higher, internal to the glutæus; it tapers as it descends and is inserted into a rough space on the outer side of the fibula just above the ankle: in Aï it is inserted into the back of the fibula and also expands upon the back of the leg as far as the heel, uniting with the gracilis: in

[1] Meckel (*Vergl. Anat.* III. 613) alludes to this insertion in Aï.

UNAU (Pl. II. *B.'*), it detaches some fibres to join the semitendinosus and the gracilis[1], and expands (*B.''*) over the back of the leg, forming a sheath over the calf and united to the edges of the tibia and fibula. In MANIS the ischial portion (Pl. IV. fig. 4, *B.*) arises from the ischium, beneath the glutæus and behind the semimembranosus, by a tendon from which pass the muscular fibres of the second part of the adductor magnus; and it is inserted into the external lateral ligament, the head of the fibula and the fascia on the outer and fore part of the leg. The femoral portion (*B.'*) arises from the outer and back part of the femur, beneath the great trochanter, far above, therefore, and quite separate from the insertion of the glutæus which is into the outer condyle. It passes down, internal to the ischial portion, crossing external to the peroneal nerve, and terminates at the lower fourth of the leg, in tendinous fibres, which are closely applied upon the peronei, but which are inserted into the outer side of the os calcis.

Semitendinosus (UNAU) from the tuber ischii, in close connection with the biceps and add. magn: (Aï) from the tuber ischii, between biceps and semimembr.; some of the fibres arise from the sacral and caudal vert.: (ANTR) from the first caudal transverse process, lying superficial therefore to the biceps and the semimembranosus. It is inserted into the inner side of the tibia, beneath the semimembr., in all. I cannot discover a tendinous intersection in it. In MANIS it has a broad origin from the three foremost caudal transverse processes, passes over the tuber ischii and is inserted into the inner side of the tibia beneath the semimembranosus.

In both the long-tailed animals, therefore (Antr and Manis), it arises from the caudal vertebræ and passes over the tuber ischii.

Semimembranosus (UNAU and Aï) from the ischium, in front of the semitend., to the inner side of the head of the tibia above it. In ANTR from the tuber ischii, in connection with the biceps and adductor magnus, to the side of the head of the tibia. A few of the upper fibres, in Aï, pass to the inner side of the femur beneath the insertion of the addr. m. In MANIS from

[1] There is thus a crossing of fibres here, a part of the gracilis passing outwards to the ischial portion of the biceps and a part of the femoral portion of the biceps passing inwards to the gracilis.

the fore part of the tuber ischii is inserted broad into the inner side of the upper part of the tibia, its upper fibres joining those of the adductor magnus over the knee joint.

Popliteus is large in all, arises from the femur, overlies, to some extent, the origins of the tibialis posticus and flexor digitorum, and has an ossicle in its tendon[1] with a smooth facet which plays upon the hinder part of the inner condyle of the tibia, the articular surface of the tibia being extended a little in this direction.

An upper and smaller facet of this sesamoid is, in each instance, applied upon the interarticular cartilage, and slightly upon the condyle of the femur; and its forepart is united to the interarticular cartilage by a stout tendinous band.

The origin of the gastrocnemius from it in ANTR (see below) seems to associate it with the outer of the two post-condyloid bones which are so often found giving origin to the gastrocnemius. The popliteus, however, had not any connection with that bone in the instances in which I have paid attention to the point; and in Jerboa I find a sesamoid in the popliteus, playing upon the tibia, distinct from the post-condyloid bone which plays upon the femur and gives origin to the gastrocnemius and the plantaris. It is to be observed also that it is the soleus only which is connected with the popliteal sesamoid in Unau. It is necessary therefore to distinguish, though that is not always done (witness Meckel, *Vergl. Anat.* III. 634), between the popliteal sesamoid and the post-condyloid or gastrocnemian sesamoid, for they are not the same. The origin of the plantaris, popliteus, and soleus from the process at the upper end of the fibula in Echidna and the occasional partial origin of the popliteus from the fibula in other animals (see footnote, p. 328 of the preceding Vol. of this *Journal*) render it probable that that process is the homologue of this popliteal sesamoid, the difference being that it has not been segmented so as to form a separate bone, or 'fabella,' or that having been segmented it has become ankylosed to the fibula.

Gastrocnemius (UNAU), the portions arising from the two condyles are separate in their whole length and cross one another. The inner portion arises, muscular, from the usual situation, immediately above the internal condyle, and terminates, above the middle of the leg, in a tendon which is inserted into the outer part of the prominence of the os calcis. The outer portion has a broad muscular origin from the outer side of the back of the femur, commencing an inch above the

[1] Meckel (*Arch.* III. 28 and 53) mentions this 'sesamoid' in Antr, and Owen (*Comp. Anat.* II. 409) in Manis as the 'fabella'.

condyle. It terminates at the middle of the leg in a tendon which crosses beneath the preceding, and is inserted into the inner side of the projection of the os calcis. In Aï the origin is like that in Unau, except that the origin of the outer portion is narrower: the flat muscular bellies are continued to the level of the ankle where they unite in a tendon, which is inserted on the inner side of the projection of the os calcis. In ANTR the inner head arises as usual, and the outer head arises not from the femur but from the sesamoid bone in the popliteus. The two unite about the middle of the leg in a tendon which is inserted into the most prejecting part of the os calcis, rather on the outer than the inner side. In MANIS there are two broad musculo-tendinous origins from the condyles of the femur. The inner derives some fibres from the second portion of the add. magnus which crosses it (Pl. IV. fig. 4); and the outer extends above the condyle into the usual position of the plantaris. They unite in a tendo Achillis inserted into the os calcis; but the inner edge of the tendon is somewhat separate from the rest and is continued on the inner side of the os calcis into tissue, from which the inner fibres of the fl. br. dig. arises. This tendon represents the tendon of the plantaris (fig. 4). Below, it is lost in the under surface of the flexor brevis. Above, it passes into the deeper surface of the gastrocnemius, but is not clearly traceable into that portion of the outer head of the gastrocnemius which represents the plantaris muscle.

There are no post-condyloid sesamoid bones at the femoral origins in either of the four animals.

Soleus (UNAU), from the upper part of the back of the fibula and, by a thin muscular slip, from the sesamoid bone in the popliteus. It is inserted into the outer part of the upper surface of the os calcis, anterior to the tendon of the inner head of the gastrocnemius. Some of its fibres run into this tendon, and some are continued into the large accessorius. In Aï it arises from the upper two-thirds of the back of the fibula, and is inserted into the upper and inner surface of the os calcis anterior to the tendon of the gastrocnemius. In ANTR it passes from the upper half of the back of the fibula, and is inserted into the os calcis on the fibular side of the tendon of the gas-

trocnemius. In MANIS it arises from the back of the fibula in nearly the whole length, and is inserted in front of the tendo Achillis into the upper surface of the os calcis, between the ankle joint and the extremity of the bone. Its fibres approach close to those of the accessorius.

Plantaris is separate only in ANTR. It arises from above the outer condyle of the femur nearly in the position of that which I have described as the outer head of the gastrocnemius in UNAU. It runs beneath the gastrocnemius to its inner side, and accompanies tendinous tissue passing from the side of the projection of the os calcis to the flat supernumerary bone. It is thus inserted into the latter bone, and serves to connect it with the os calcis and to carry the pad.

Thus the *plantaris* in ANTR corresponds almost exactly with that which constitutes the only representative of the outer portion of the *gastrocnemius* and of the *plantaris* in UNAU; and in ANTR the only representative of the outer portion of the *gastrocnemius* corresponds in its origin with the slip that forms part of the soleus in UNAU. In AÏ there is a peculiar feature introduced by an extension of the fl. dig. to the femur, which seems to represent the plantaris. In MANIS, so far as it is distinguishable, it takes the usual course; but it is not separate from the gastrocnemius.

Tibialis posticus (UNAU) as usual from the back of the tibia. It consists however of two portions—a larger portion (Pl. II. *Tib. p.*) the tendon of which descends behind the inner malleolus, beneath the inner part of the scaphoid but unconnected with it, along the outer surface of the ento-cuneiform bone to which it sends some fibres, and is chiefly inserted into the base of Met. II. The smaller portion (*Tib. p.'*) internal to the other, terminates in a tendon which descends in a separate channel on the inner side of the malleolus, passes over the most projecting hinder point of the ento-cuneiform, and is continued onwards into a small fusiform muscle (a portion of the flexor brevis) which terminates in a fine tendon that crosses the sole and becomes blended with the tendon of fl. br. to digit IV. In Aï it is single and small, extends along the inner and posterior surface of the tibia, a little beneath the popliteus, and has one tendon which passes in a deep groove on the back of the malleolus and is inserted into the ento-cuneiform. In ANTR it arises from the back of the tibia and also from the

head of the fibula extending up beneath the popliteus. The inner and larger portion of the muscle, including all that derived from the tibia and some of that from the fibula, terminates at the lower third of the leg in a tendon which, passing behind the malleolus, is inserted into the middle of the supernumerary bone. The outer and smaller portion, derived exclusively from the head of the fibula, terminates in the upper third of the leg in a delicate tendon which, passing in a separate channel, deeper than the other tendon, is inserted into the hinder edge of the ento-cuneiform[1].

In MANIS there are two distinct muscles. The first (Pl. IV. fig. 4, *Tib. p.*) arises from the back of the upper third of the fibula, in conjunction with the soleus, and from the oblique line in the tibia beneath the lower edge of the popliteus, and is inserted into the inner side of Met. I. The second (*Tib. p.'*) arises, deeper, from the inner side of the upper third of the fibula close to the flexor digitorum, and from the back of the tibia beneath the first portion, running up, like it, for some distance under the popliteus: its tendon passes in a separate channel, external to that of the first portion, and is inserted into the ento-cuneiform bone.

These divisions of the tibialis posticus, especially that in Unau, are a little perplexing and difficult to harmonize with the disposition of it and the adjacent muscles in other animals. The first or inner portion corresponds generally in its origin with the flexor digitorum of man and some others; and the course of its tendon in Unau throws it into relation with the flexors of the toes. Yet in Manis its tendon lies internal at the ankle, and has the usual insertion of the tibialis posticus. In Orycteropus (Vol. II. of this *Journal*, p. 314) the disposition is particularly interesting. The muscle consists, as in these animals, of two parts; and the inner or tibial part shows a closer relation to the flexor of the digits, for, besides being inserted into Met. I., it sends a slip to the flexor digitorum, and another to the plantar fascia. The plantar fascia is in that animal the representative of the short or superficial flexor; the slip to the plantar fascia may, therefore, be looked upon as the homologue of

[1] Meckel describes this smaller portion as the flexor hallucis. It is, however, closely connected with the tibialis posticus above, and has the usual insertion of the tibialis posticus below, and is quite on the tibial side of the fl. dig. Moreover a distinct fl. longus hallucis is by no means common in the lower animals. The division of the muscle in Antr seems rather to correspond with that stated by Meckel (*Vergl. Anat.* III. 637) to be found in Marmots. Galton, *l.c.* 558, found a *tibialis posticus secundus* in Dasypus, inserted into an ossicle alongside the fore edge of the ento-cuneiform bone.

the part of the muscle which, in Unau, is continued into one of the divisions of the flexor brevis.

The explanation, in general terms, seems to be that the segmentation of this deep muscular plane is somewhat variable. The fibular part is pretty constant as a flexor of the digits; and the tibial part is disposed in one, two, or more parts to the tarsus, metatarsus, or digits, or all three, as occasion may require. When a subdivision of this tibial part takes place the outer or fibular portion goes to the tarsus, forming the true tibialis posticus, and the inner or tibial element is distributed, partly to the tarsus and partly to the digits, or, as in man, entirely to the digits forming the flexor longus digitorum.

Flexor digitorum (UNAU) arises from the tibia and fibula, and slightly from the popliteal sesamoid. The tibial portion is deep, being covered by the fibular portion and the tibialis posticus, the fibres of which are, to some extent, blended over it; and the tendon derived from this portion, crossing beneath those proceeding from the fibular portion, goes to digit IV. The fibular portion, passing on the inner side of the astragalus in the same channel with the fibular portion, gives rise to two tendons which pass to digits II. and III. All the tendons join the deeper surface of those from the front of the leg presently to be described. In Aï it arises in three portions—the largest[1] from the line ascending from the outer condyle of the femur and forming the outer boundary of the popliteal space, above the outer head of the gastrocnemius. The smallest portion arises from the back of the tibia; and the third portion is from the back of the fibula. The three are blended at the lower part of the leg into a tendon which occupies a wide deep channel on the outer side of the malleolus and gives rise to three tendons to the three digits. The femoral portion does not maintain a superficial relation, but passes into the tendon to digit III: the chief of the tibial portion lies deep and passes to digit II; and the chief of the fibular portion lies superficial to the rest and passes into the tendon to digit IV. The crossing of the tibial portion beneath the others to digit IV, as in UNAU,

[1] I do not find that this femoral origin of the fl. dig., which may be considered to represent the upper part of the plantaris, is described by Meckel. He seems (*l. c.* 630) to regard it as part of the outer origin or the gastrocnemius, which he describes to be very large in this animal. It is described as plantaris by Prof. Macalister. It may be observed that in Pteropus (preceding vol. p. 314) the fl. dig. has an origin from the tibial condyle of the femur.

is confined to a few fibres. In ANTR it arises from the back of the tibia and fibula by two heads which lie beneath the tibialis posticus and extend up beneath the popliteus. They unite to form one strong tendon which divides to the four toes.

In MANIS it arises from the back and inner part of the fibula in nearly its whole length in conjunction with the soleus and the tibialis posticus, but deeper than these, also from the back of the lower part of the tibia. The tibial and fibular fibres meet in a penniform manner in a tendon which is large in the sole, plays upon flat smooth surfaces of the cuneiform and cuboid bones, and divides to the terminal phalanges of the five digits.

Lumbricales (UNAU) are three: one arises entirely from the tendon of the tibialis anticus which passes to digit III: the second arises partly from the tibialis anticus (from the cleft between the divisions to digits II. and III), and partly from the fibular portion of the fl. dig. or the fibres of the accessorius which join it: the third arises, partly, from the tibialis anticus (from the outer side of the division to digit III), and, partly, from the fibres of the accessorius passing to the tendon of digit IV. They run on the tibial sides of digits II, III, and IV, and join the extensor tendons, not being connected with the phalanges. They are absent in AÏ. In ANTR there are three passing from the clefts of the tendon of the fl. dig. to the tibial sides of the three outer digits. I do not find one connected with digit II.

In MANIS there are three arising by flat tendons from the plantar surface of the fl. dig. close to its division to the three inner digits. There is but little interval between the origin of the lumbricales and the fibres of insertion of the accessorius; and by dissection continuity between them may be shown to some extent. In the instance of the outer one the muscular fibres are continuous with the muscular fibres of the accessorius. They pass to the tibial sides of the first phalanges of digits II, III, and IV. The third, or outermost, divides and passes to the fibular side of digit III. as well as to the tibial side of digit IV.

The origin of the lumbricales from the tibialis anticus in Unau is well worthy of note. The relation to the accessorius, remarked in Unau and in Manis, is probably not unusual. In Pteropus (preceding Vol. p. 315) several of the lumbricales pass, as in the instance of

the third in Manis, to the fibular as well as the tibial sides of the digits.

Accessorius is present and large in all. In UNAU and AÏ it arises from the whole of the anterior and outer surface of the back of the long heel-bone, and (in UNAU) is continuous with the soleus. In UNAU the largest part of it joins the tendon to digit IV, and the remainder the other two tendons. It is inserted into the several tendons at the junction of the components from tib. ant. and fl. dig.; so that the two muscles—accessorius and tib. ant.—coming from opposite sides serve to neutralize the tendency of each other to draw the tendons of the toes laterally. In AÏ it divides into three portions which are inserted into the plantar surfaces of the tendons to the three digits. In ANTR it arises from the fore part of the projection of the os calcis, and is inserted into the plantar surface of the flexor tendon just before its division.

In MANIS it passes from the under and outer surfaces of the os calcis to the plantar or superficial surface of the broad tendon of the fl. dig. before the division; and its fibres may, by a little dissection, be traced into all the flexor tendons as well as into the lumbricales.

The accessorius is, in these animals, not only a powerful adjunct to the flexor of the toes, but seems also to prevent the drawing of the flexor tendon inwards at the ankle. Provision against this displacement, which is partly afforded by the deepening of the inner side of the groove in which the tendon lies at the malleolus, is especially needed in the Sloths, in consequence of the strength and continued action of the flexor muscle and the inturned position of the foot. The need is further increased in Unau by the powerful tibialis anticus joining the flexor digitorum.

I suspect that this muscle, which has come to be, as its name implies, an accessory, is, in reality, the original or true flexor. I think it will turn out, though I am not able quite to satisfy myself of this, that the planes of flexors on the plantar aspect, like the two planes of extensors on the dorsal aspect (p. 69), are, in the typical condition, confined to the foot and are represented—the superficial plane—by the flexor brevis digitorum and—the deep plane—by the accessorius; that these constitute the primary and essential parts; and that the extensions up the leg—the plantaris of the superficial plane and the belly of the flexor digitorum of the deep plane, like the extensor digitorum on the dorsal aspect—are the secondary and accessory parts. The accessorius, if this view is correct, is the plantar (that is flexor or antagonistic) homologue of the

extensor brevis; the flexor digitorum and the tibialis posticus are the antagonistic homologues of the deep layer in the front of the leg[1]; and the plantaris is the antagonistic homologue of the extensor longus digitorum. The occasional interruption of continuity of the superficial flexor layer and the insertion of its crural part (the plantaris) into the tarsus (as into the heel-bone in man) becomes thus an interesting feature of similarity to the occasional interruption of the superficial extensor layer and the insertion of its crural part into the metatarsus, as witnessed in Aï (p. 68).

The large size of the muscle in these four animals is in remarkable contrast with its rudimentary, merely tendinous, condition in Orycteropus (Vol. II. 317).

Flexor brevis digitorum (UNAU) well marked in three portions, one to each of the digits. One portion (Pl. II. Fl. br′.) arising from the projecting hinder part of the ento-cuneiform, is joined by a portion (Fl. br″.) from the os calcis: it passes to digit II. The two other portions (Fl. br.) arise from the extremity of the os calcis superficial to the accessorius, that to digit IV. receives an accession from the internal division of the tibialis posticus (see description of that muscle): all terminate in the flexor sheaths, that to digit II. on the fibular side, that to digit IV. on the tibial side, that to digit III. in the middle. In Aï it is a small flat thin muscle arising from the point of the heel-bone and having three tendons which are disposed as in Unau. In ANTR it arises as usual and sends a tendon to each of the four digits. In MANIS it consists of four portions arising from the fore part of the extremity of the os calcis and passing to the four outer digits where they are disposed in the usual manner, except that the division to digit V., which arises rather deeper than the others, in closer relation to the accessorius, as well as external to them, passes only to the outer or fibular side of the digit and is inserted into the outer sesamoid bone of the metacarpo-phalangeal joint. The inner portion is connected with the outer part of the tendo-Achillis which represents the plantaris.

[1] The segmentation in the two cases however is somewhat different, inasmuch as the deep extensor of the digits (Ext. br.) is confined to the foot, and is not usually, like its antagonistic homologue in the sole, continuous with any part of the muscular structure of the leg.

I drew attention (preceding Vol. p. 320) to this 'antagonistic homology' of muscles, without using the term, in the instance of the flexors and extensors of the leg and forearm.

The similar peculiarity of the superficial flexor passing to the ulnar side of digit v. is noted with regard to the fore limb in Manis (p. 44).

Transversalis; a very distinct muscle in UNAU, arising tendinous from near the distal end of Met. V; it divides into two portions, of which one is inserted into the distal end of Met. I. and the other into the fibular side of the proximal end of the first phalanx of digit II. (See account of this muscle in MANIS in the description of the small muscles of the palm and sole, p. 74.)

There are three *cutaneous* muscles in the sole of the foot in UNAU; one radiates from the slightly enlarged end of Met. I, backwards into the skin, and another radiates in a similar manner from Met. v. Some of the fibres of these two nearly or quite meet. A third passes backwards from the flexor sheath over the metatarso-phalangeal joint of digit II. In MANIS a broad muscle extends from the metatarso-phalangeal joints of digits I. and II. backwards into the skin of the sole, and another from the metatarso-phalangeal joint of digit V. radiates also into the sole.

Tibialis anticus in UNAU and Aï consists of three portions—one arising from the outer surface of the upper half of the tibia; a second arising from the middle third of the fibula where the ext. hallucis, which it appears to represent, usually arises. These two portions come into contact in the lower part of the leg, and in Aï are inserted together into the inner margin of the conjoined entocuneiform and rudimentary first metatarsal, the fibres of the tibial portion being more internal or marginal than those of the fibular portion. In UNAU (Pl. II. *Tib. a.*) their conjoined tendon does not stop at this the usual terminus but passes over the inner side of the instep in a wide groove in the entocuneiform which is deepened behind, by the projection of that bone, and in front, by the projection of the base of Met. I. Here it divides into three tendons which join the surface of the tendons of the flexor digitorum. The fibular portion furnishes the tendon to digit II., the tibial portion that to digit IV., and both furnish that to digit III. The third portion of the muscle (*Tib. a'.*) arises from the lower and fore part of the fibula including the malleolus, internal to the peroneus brevis. It

passes athwart the ankle and is inserted into the entocuneiform and base of Met. I., its fibres lining, in Unau, the groove in which the tendon from the remainder of the muscle passes and, in Aï, being inserted just beneath that tendon[1]. In ANTR the muscle consists of two portions only, corresponding with the first and second of Unau and Ai; and the tendon of these is inserted into the entocuneiform bone between the supernumerary bone and the metatarsal.

In MANIS also the tibialis anticus (Pl. IV. fig. 2. *Tib. a.*) consists of two portions. One, larger and internal, arises from the outer side of the upper two thirds of the tibia and from the head of the fibula, lying beneath the extensor longus digitorum; and the other from the anterior edge of the upper three fourths of the shaft of the fibula, between the first portion of the tibialis anticus and the extensor hallucis and in a plane with them. The tendons of the two run together over the ankle; that of the tibial portion is inserted into the entocuneiform bone and that of the fibular portion into the inner side of the base of the metatarsal of hallux.

In all four therefore, the muscle arising from the part of the fibula which usually furnishes attachments to the ext. hallucis passes with the tibialis anticus and contributes with it to form a powerful rotator of the foot inwards; and this movement is in the Sloths strengthened by the third portion from the lower end of the fibula.

The continuation of portions 1 and 2 to the flexor tendons in Unau is very remarkable. I do not know any other instance of the same thing; and a flexor action is thus given to muscles which are usually extensors. This becomes less striking when we remember that the tibialis anticus is often associated in its action as a rotator inwards with the flexors of the foot and toes; and in cases of ordinary club foot (talipes varus) it combines with the muscles which we are in the habit of regarding as its antagonists to produce the deformity, and requires to be divided with them in the operation for cure. Its association with the flexors, its prolongation to the sole in Unau may be compared with what is usual in the case of its fibular compeers—the peronei. These, two of them at least—peroneus longus and brevis—though members of the extensor group, become, by virtue of their relations to the outer malleolus and the continuation of one of them into the sole, flexors of the ankle, and are associated in their

[1] This portion, which is not mentioned by Meckel or Macalister, seems to correspond with a muscle in the Frog, passing from the lower end of the fibular side of the leg bone to the fore part and inner side of the astragalus and called by Dugès (*Recherches sur les Batrachiens*) *péronéo susastragalien*, and by Ecker (*Anatomie des Frosches*) *flexor tarsi.*

action with the tibialis posticus and the flexors of the toes. Moreover the combination in one muscle of flexor action upon one joint and extensor action upon another joint is not so unfrequent as we might suppose. In Manis (p. 35) the latissimus dorsi extends the elbow and flexes the digits; and in some birds the rectus extensor cruris is continued into the flexor digitorum.

Extensor digitorum in UNAU and AÏ arises by a tendon from the external condyle of the femur, in front of the external lateral ligament. In Unau it is a thin muscle and divides into two tendons to the digits III. and IV. In Aï it is larger, muscular all down the leg, and is inserted by a short thick tendon into the upper surface of the proximal end of Met. III. not extending to the digits at all. In ANTR its origin is confined to the head of the tibia, it is not large and divides into four tendons to the four digits. (In MANIS, see below.)

Extensor brevis digitorum is large in all. In UNAU and AÏ it arises from the dorsal surface of the tarsal bones and of the proximal parts of the metatarsals and passes to the terminal phalanges of all the digits, having no connection with the proximal phalanges. It constitutes with the interossei the only extensor of the several digits in Aï and of the inner or second digit in UNAU. In the latter animal it joins the under surface and both sides of the extensor tendons to digits III. and IV. In ANTR it arises from upper surface of the os calcis and divides into four separate portions which become united with the tendons of the long extensor.

In MANIS the *ext. digitorum* (Pl. IV. fig. 2, *Ext. d.*) has a thin flat tendinous connection with the fore part of the outer condyle of the femur and a muscular origin from the head of the tibia and of the fibula and from the upper fourth of the fibula in conjunction with the peroneus longus. It divides into four tendons which are inserted into the dorsum of the first phalanges of digits II, III. and IV.; and it sends a delicate slip to digit V. This joins the peroneus tertius and is inserted into the terminal phalanx.

The *Ext. brevis* (*Ext. br.*) arises from the fore part of the os calcis and divides into three portions, one to the outer side of digit IV., a second to the adjacent sides of digits IV. and III., and a third to the adjacent sides of digits III. and II. All the tendons pass on to the terminal phalanges.

Extensor longus hallucis (*Ext. h.*) arises from the lower fourth of the anterior surface of the fibula, beneath the peroneus tertius, below and in the same plane with the tibialis anticus. Having passed over the ankle it divides into three portions, one to the inner side of digit II. extending to the terminal phalanx, a second to the terminal phalanx of digit I., and a third to the proximal phalanx of digit I.

The study of the extensor group in these four animals and the comparison of them with the corresponding group in the frog are highly interesting and instructive, and afford, I think, a key to the arrangement of these muscles.

In the FROG the middle muscle in the front of the leg, which corresponds apparently with the crural or upper part of the extensor digitorum in mammals, reaches only to the tarsus, being inserted into the tibial and fibular sides of the two long tarsal bones; and the extensors of the digits are limited to the foot and are in two planes. A *superficial* plane proceeds from the anterior surface of the upper part of the os calcis and divides into four or five portions, the tendons of which are inserted into the several *proximal* phalanges of the digits. The *deeper* plane arises from the os calcis lower down, divides into twice as many bundles as the superficial plane, and two bundles pass along the sides of each of the superficial tendons, extend beyond them and reach the terminal phalanx of each digit. This is only a general description, but it is sufficient for my purpose[1].

In Aï the disposition so far resembles this of the frog that the crural part of the extensor group reaches only to the metatarsus, and the tendons to the phalanges are entirely derived from the pedal portions; but, owing probably to the comparative immobility of the proximal phalanges, none of the tendons are inserted into them; they are all continued on to the distal row; and the muscle is, accordingly, not distinctly divisible into two planes. In UNAU, in like manner, the extensor tendons all pass on to the terminal phalanges, and the pedal part is in one plane, and is the sole extensor of digit II. Here however, there is a further departure from the frog, inasmuch as the crural portion does not stop at the tarsus, but is continued on as an extensor of digits III. and IV. It is not, however, continued to digit II., the extensor of that digit being, like the extensors of all the digits in Aï and the Frog, confined to the foot. In ANTR the deviation from the Frog is greater still, for the superficial plane from all the digits extends up the leg and has become altogether crural; and the pedal part or deep plane, though more separate than in the Sloths, is still a good deal blended with the superficial or crural plane.

In MANIS (and we may probably take this as the typical arrangement when the superficial plane extends up the leg and acquires a

[1] The deep plane is not segmented from the interossei, and its components are described as interossei by Dugès and Ecker.

crural or femoral attachment) the tendons of the superficial, which is also the crural plane, are inserted into the proximal phalanges; and each is flanked, on both sides, by the tendons of the deep or pedal plane which pass on to the terminal phalanx. There is here, therefore, a reversion to the plan of the frog though a difference from the Frog is shown, in that the crural and pedal parts of the superficial plane are united into a continuous muscle.

In Mammals generally a conformity to this typical plan is shown in the following way: the tendons of the superficial or crural plane (the *extensor digitorum longus*) extend to and are attached to the middle of the dorsal surface of the proximal or middle phalanges; while the tendons of the deep or pedal plane (the *extensor digitorum brevis*) run more laterally and reach the terminal phalanges. There are, however, commonly deviations from the plan in that the deep tendons are single, instead of being double, to each digit and are confined to the fibular side; they are more closely united with the tendons of the superficial plane than in Manis and the Frog; and prolongations of the superficial tendons extend, especially on the tibial sides, to the terminal phalanges. I have in a former paper (Vol. III. of this *Journal*, p. 317) suggested that the passage of the lumbricales to the tibial side of the digits may perhaps be explained by the absence of the short extensor tendons on this side; and I drew attention to the fact that in Pteropus, where the short extensors are disposed on both sides of the long extensors, the lumbricales also pass on to both sides of the digits.

To prevent obscurity I have reserved the consideration of the marginal digits (I. and V.) because, being more specialized, these present still greater deviations from the regular plan. In digit I. both the extensor tendons—*proprius* and *brevis*—are inserted into the terminal phalanx, thus presenting the usual insertion of the tendons of the deeper plane; and the disposition in Manis shows pretty clearly that they really belong to this plane. In that animal they both spring from the same muscle, which, by its manner of connection with digit II. is linked on to the deep series notwithstanding the peculiarity which it presents, in imitation of the components of the superficial series, by shifting its ground from the pedal to the crural region and acquiring an origin from the fibula instead of being confined to the tarsus. If this view be correct it is the superficial or 'long' element which is wanting in digit I; and we may associate the deficiency with the absence of that phalanx into which the superficial tendon is usually inserted.

Now the last-mentioned muscle (*extensor hallucis*) is, in Manis distinctly and in most mammals more or less distinctly, in the same plane with the *tibialis anticus* as well as with the *extensor brevis*, and is closely connected with it. So that we find here a deep plane, arising from the tarsus, the fibula, and the tibia, the fibres of which run with more or less obliquity from the fibular to the tibial side, and which is segmented in the direction of its fibres—somewhat differently in different animals—into two chief parts, of which one (*tibialis anticus*) is inserted into the inner side of the tarsus, and the

other (*extensor brevis digitorum*) is inserted into the terminal phalanges of the digits. There is also, commonly, a third or intermediate segment (*extensor hallucis*) which may be derived from either or both of the others and which connects the others, but which from the intervention of the ankle joint is more separate from the extensor brevis than from the tibialis anticus. Indeed it is not unfrequently merged in the latter. This seems to be the case in Unau, Aï and Antr; and in Manis it occupies a part of the ground of the fibula from which the ext. hallucis usually arises.

With regard to the other marginal digit (v.) the deep or short extensor often fails in it, as I have just said the superficial or long extensor fails in digit I; and the deficiency is in many animals compensated for by an extension from the peronei to the phalanges. The peronei are parts of the superficial plane, so that digit v. usually receives two tendons from the superficial plane, digit I. has two tendons from the deep plane, and the intermediate digits have one tendon from each plane.

In the fore limb also a similar plan may be traced, though it is more often and more largely departed from to meet the freer movements and more special requirements of this member. The two layers are easily distinguished; and both usually extend beyond the carpal region upon the forearm. The superficial layer forms the extensor digitorum, and even in the Frog springs from the outer condyle of the humerus, constituting the middle muscle on this surface of the forearm. It supplies the three outer digits, being inserted into one of the proximal phalanges or extending to a terminal phalanx. Beneath this is the deeper layer, which in the Frog is partly pedal, that is to say, the muscles which supply the three outer digits arise from the carpus, and pass on either side of the digits mostly to the terminal phalanges. The inner digit (No. II.) like the hallux in Manis, receives two tendons which pass from the ulnar side of the forearm, beneath the long extensor, and are inserted into a proximal and the terminal phalanges, or are both inserted into the terminal phalanx.

In Mammals, as in the Frog, the superficial, long, vertical muscle passes from the humerus to the three or four outer digits, and is inserted, in great part at any rate, into the proximal or middle phalanges. The deeper short, oblique layer we have found in Unau and Aï, corresponding with the deep layer in the hind limb and with the same layer in the fore limb of the Frog, to arise in part from the carpus, to be applied (in Unau) to both sides of the long extensors, and to reach the terminal phalanges. In Antr this part of the deep layer extends upon the ulna; and in most mammals where it exists it extends up the forearm, and is not unfrequently blended with the extensor longus. Its tendons may, however, usually be recognised by their reaching to the terminal phalanx, and by their running on the ulnar side of the long extensors[1]. In most instances the pollex, like the hallux, is supplied exclusively from this deep oblique layer,

[1] I have described it as '*extensor digitorum secundus*' in Phoca (Vol. II. of this *Journal*, p. 307).

receiving one, two, or more tendons from it; and the index digit often receives a tendon on its ulnar side from the same source; or it may be entirely indebted to the superficial layer for its extensor muscles.

Continuous with this deep layer, and forming indeed the most constant element of it, and related to it in the same way that the tibialis anticus is related to the deep extensors in the hind limb, is a muscle which, from human anatomy, is usually called *extensor ossis metacarpi pollicis*, but which from its far more constant insertion into the carpus is better designated *rotator carpi*. Its course and relations as well as its action indicate this muscle to be the serial homologue of the outer part of the tibialis anticus. I say of the outer part because the inner part seems to be represented by the extensor carpi radialis. I do not say this at all positively; but the relations of the tendon of the extensor carpi radialis and its position close to the bones beneath even the rotator carpi—a position very regularly observed—show that it belongs to a deep series, although, above, it has like some of the other members of the deep series just mentioned, and like the rotator carpi in Antr, passed into the superficial level and reached the outer condyle of the humerus. By the process of exhaustion there is no other representative of this muscle left in the hind limb except a part —the inner or tibial part—of the tibialis anticus. The fibres of this part show a tendency as they descend to cross beneath those which have a more external origin, and it seems not improbable that their homologues in the fore limb do so cross and form a separate muscle or muscles which reach the third metacarpal, or the second as well as the third, and constitute the single or double radial extensors of the wrist[1]. With regard to the marginal digits (I. and V.) in the fore limb the pollex (I.) is, as above said, supplied exclusively, like the hallux, from the deep or oblique layer. The small digit (V.), like its homologue in the hind limb, is supplied from the superficial layer; and to compensate, as it were, for the want of supply from the deep layer it receives an accession (*extensor minimi digiti*) from the superficial layer, from between the extensor carpi ulnaris and the extensor digitorum, which corresponds therefore in position with the *peroneus tertius*. Like this its homologue it not unfrequently supplies the adjacent digit (IV.) as well as V. In Manis this muscle is of large size, and the similarity of it and of the extensor carpi ulnaris to the peronei is very obvious.

It will be perceived therefore that in the fore limb, as well as in the hind limb, digit I. is supplied exclusively from the deep plane, and digit V. from the superficial plane, each commonly receiving two tendons

[1] In a large dog of the St Bernard breed I found two tendons inserted into the second and third metatarsals and apparently, therefore, serially homologous with those of the extensores carpi radiales. These were derived from the contiguous parts of the extensor brevis digitorum and the extensor hallucis. To have shown a more full correspondence with what I suppose to be their homologues in the fore limb, their muscular parts should have run up beneath extensor hallucis; but the attempt, as one may call it, at similarity is interesting and rare.

from its plane. The intermediate digits are not so frequently as in the hind limb supplied from both planes; their extensors are usually derived from the superficial series only, or the deep elements which belong to them are more or less blended with the superficial.

Interossei in UNAU and AI are large, situated on the dorsal aspect of the foot, lie nearly in the same plane, and terminate in the extensor tendons. There is one on each side between each of the three large metacarpals, i.e. two between Mets. II. and III. passing to the fibular side of the tendon to digit II. and to the tibial side of the tendon to digit III., and two between Mets. III. and IV. which are similarly arranged with regard to the adjacent tendons. There is also one on the tibial side of Met. II. extending between it and Met. I. and passing to the tibial side of the tendon to digit II.; and there is one on the fibular side of Met. IV. extending between it and Met. V., passing to the fibular side of the tendon to digit IV. They extend through, on to the plantar aspect, between the large metacarpals; and the palmar portions appear to be connected chiefly if not exclusively with digits II. and IV. so as to adduct them to digit III. In Unau there are fibres corresponding with what I have described as phalangeal interossei in the fore limb, but less distinct. Each extensor has thus two interossei attached to it, one on each side. In ANTR there is one on each side of each of the four outer digits, and passing chiefly to the extensor tendons. The muscles adducting to digit III. are distinctly on the plantar surface and are large, whereas those abducting from the line through digit III. are smaller and more on the dorsal surface; the distinction between plantar and dorsal interossei being more clear than usual. There is an adductor, a short flexor, and an adductor of digit I.; the two first arising from the supernumerary bone, the adductor from the ento-cuneiform. A thick muscle, covered by tendinous tissue, passes from the outer part of the os calcis to a projection on the outer surface of the base of Met. V.; and some of the fibres are continued on to the first phalanx; this is *abductor* of the fifth digit.

In MANIS (Pl. IV. fig. 5), the arrangement of the small muscles, though generally resembling that in the fore limb of this animal, presents some differences. The *abductor* and *flexor brevis pollicis* arise together by a tendon from the scaphoid bone,

lying internal to the tendons of the tibialis posticus. The abductor, receiving accessorial fibres from the side of the metacarpal, is inserted into the tibial side of the first phalanx. The fl. brevis is inserted into the inner or tibial side of the sesamoid. The *flexor brevis* and *abductor minimi digiti* are very small, arising only from the short metacarpal and inserted into the outer sesamoid and side of the phalanx. There are five *plantar interossei*. Three arising from the fore part of the cuboid and cuneiform bones, near the middle of the foot, radiate to the fibular side of digits I. (the *adductor pollicis*) and II. and to the tibial side of digit V: they are inserted chiefly into the phalanges and slightly into the sesamoids, and are adductors to the middle digit. The two remaining plantar interossei are situated on a rather deeper plane, nearer to the metatarsals, and pass, one to the fibular side of digit III., and one to the fibular side of digit IV. They are therefore abductors from the axis of the middle digit. A *transversus* connects the interossei of digits V. and II. by passing, muscular, from the first phalanx of V., across Mets. IV. and III. and the two abductor interossei of these digits, and being inserted into the first phalanx of digit II.

The *dorsal interossei*, corresponding very closely with those in the fore limb, pass to both sides of the three middle digits, and to the tibial side of digit V. reaching the terminal phalanges in company with the short extensor tendons. The abductors from the axis of the middle finger preponderate, and are superficial, as do the adductors to the same line in the sole. Thus the first and third dorsal interossei arise from both the respective adjacent metatarsals, and pass to the tibial sides of digits II. and III.; whereas the second dorsal interosseus is deeper, arises from Met. II. and passes to the fibular side of digit II. In like manner the muscle to the fibular side of digit III. (abductor), usurps the chief of the space between Mets. III. and IV. covering and dwarfing that (abductor) to the tibial side of digit II. Those occupying the remaining interspace are more equal and pass to the apposed sides of digits IV. and V.

The disposition of the interossei in UNAU, Aï, and ANTR is in accordance with the mammalian rule that those on the palmar aspect adduct to digit III., and those on the dorsal aspect abduct from the axis of that digit.

In the fully developed condition of these muscles there is one palmar and one dorsal interosseus on each side of each digit; that is, there are four in each metacarpal interspace, two passing on each side. This is the case in the Scinc. Now in Manis there is an intermediate condition between the ordinary Mammalian and the Reptilian condition. Both on the plantar and the dorsal aspect, especially on the latter, the muscles are double in some of the metacarpal interspaces; but even then, in accordance with the mammalian tendency, the adductors to the middle digit encroach upon the palmar aspect and the abductors from the same preponderate upon the dorsum.

Peroneus longus (UNAU) from the back of the fibula in nearly its whole length, passes behind the outer malleolus, along the groove in the cuboid, and is inserted chiefly into the base of Met. IV. A small portion of the tendon extends on to Mets. III. and II.; and a few fibres even reach the rudimentary Met. I. In Aï it arises partly from the outer condyle of the femur by the tendon common to it with extensor digitorum, and partly from the upper two-thirds of the fibula. It is broad and flat, lies in front of the ankle, and is inserted into the outer surface of the rudimentary Met. V., not extending into the sole. In ANTR it arises from the fore part of the head of the fibula, descends on the outer side of the malleolus, passes as usual into the sole, is connected with the heads of the metatarsal bones sending a few fibres to III. and II., and terminates by being inserted into the ento-cuneiform.

In MANIS (Pl. I.) it arises from the fore and outer part of the upper end of the fibula. Its tendon passes behind the outer malleolus, along the groove in the cuboid as usual, detaches some fibres to the outer part of the base of Met. V., and is chiefly inserted into Met. II. Some fibres, however, pass into Met. I.

The insertion of this muscle in Aï into Met V., which agrees with the account given by Macalister (p. 15) and by Meckel (p. 626), is an interesting and rarely presented similarity to the usual disposition of its serial homologue the ext. carpi ulnaris, which seldom extends beyond the base of the fifth metacarpal. The view taken in Cuvier's *leçons* (641, 642) is that this muscle is the peroneus brevis, and that the peroneus longus is absent. Forasmuch however as it has so high an origin, and as there are two or three peronei, it may, I think, be fairly regarded to be the Peroneus longus. Moreover we find intermediate conditions transitional, as it were, to this. Thus in Manis and Orycteropus (Vol. II. 319) some fibres are detached, from

the tendon, to Met. v.; and this is not uncommon: in Antr fibres are inserted into Mets. II. and III.; and in Unau the chief insertion is into Met. IV., though some fibres pass on to Mets. III. II. and I.

Peroneus brevis (UNAU and AI), quite a short flat muscle arising from the fore and under part of the lower end of the fibula, from the malleolus that is, to the outer part of the base of Met. V. It thus diverges from the lowest portion of the tibialis anticus, and acts as an antagonist to it. In ANTR it arises from the outer and back part of the shaft of the fibula, is larger than the peroneus longus, internal to which it crosses at the ankle, and is inserted into the outer side of Met. V. just in front of the projection at its base. A thin tendon from its fore part runs along digit V. joining the extensor tendon.

In MANIS (Pl. II. fig. 2) it arises from the back part of the middle of the fibula, comes beneath the per. l. behind the outer malleolus, and is then joined by a thick muscular portion which arises from the lower end of the fibula, and which corresponds with the only representative of the muscle in the Sloths. This muscular portion joins its inner aspect; and the broad tendon resulting from the two is inserted into the base and along the outer border of Met. V., and the outer side of the first phalanx. A thin tendinous slip passes forwards from it to join the extensor tendon of digit V. and is inserted into the first phalanx.

Peroneus tertius (UNAU) from the fore part of the fibula to the upper edge of Met. V., some fibres going to Met. IV. In AI it arises from the same tendon as the ext. dig. and is inserted into the upper surface of the base of Met. IV. In ANTR I do not find any representative of it. In MANIS (Pl. III.) it arises from the lower half of the anterior edge of the fibula, there being an interval between it and the ext. digitorum. It forms the chief part of the extensor tendon of digit V., but is inserted into its first phalanx. A part of it also passes to the first phalanx of digit IV.

PLATE I.

The bones in situ of the fore and hind feet of Unau, Aï, Anteater, and Manis.

PLATE II.

Hind limb of Unau. *Gr.*, upper part of gracilis reflected. *S.*, sartorius. *Ad. l.*, adductor longus. *Pect.*, pectineus. *Ad. br.*, adductor brevis. *Ad. m.*, adductor magnus. *V. i.*, vastus internus. *Gr′.*, lower part of gracilis reflected. *Tib. a.*, tibialis anticus continued into the flexor digitorum. *Tib. a′.*, third part of tibialis anticus inserted into entocuneiform and Met. I. beneath, and on either side of Tib. a. *Inteross.*, internal interosseus. *Lumbr.*, lumbricales. *Fl. br.*, flexor brevis digitorum. *Fl. br′.* portion of flexor brevis from entocuneiform joining *Fl. br.″* from os calcis. *Ac.*, accessorius. *Fl. d.*, flexor digitorum. *T. A.*, tendo-achillis. *Tib. p.*, tibialis posticus. *Tib. p′.*, part of tibialis posticus passing to flexor dig. br. *B.*, ischial part of biceps. *B′.*, portion of femoral part of biceps passing to gracilis and semitendinosus. *B″.*, portion of femoral part of biceps expanding upon back of leg. *S. Memb.*, semimembranosus. *Ad. m.*, adductor magnus. *S. tend.*, semitendinosus. *Gl.*, glutæus magnus.

PLATE III.

Fig. 1. One side of Manis superficially dissected showing the pannicle, &c. *Trap. delt.*, trapezio-deltoid muscle. *Fl. d. s.*, flexor digitorum sublimis; the pin is passed under the part connected with pollex. *P.*, part of pannicle passing upon the back and neck, divided and reflected. *Lat. d.*, latissimus dorsi. *Br. l.*, brachio-lateral. *Pect.*, pectoralis major. Behind, the mixed fibres of the panicle, brachiolateral and external oblique cover the body and pass upon the thigh.

Fig. 2. Deeper dissection of the front of the forearm on larger scale. *Tr.*, triceps. *Lat. d.*, latissimus dorsi continuous with the part of *Fl. d. s.*, (flexor digitorum sublimis) to digit III., which has been divided and reflected over the olecranon. *Fl. d. s′.*, reflected second origin (from internal condyle) of the part of flexor digitorum sublimis to digit III. *Fl. d. s″.*, flexor digitorum sublimis to digit II., arising from inner condyle. *Fl. d. s‴.*, and *Fl. d. s⁗.*, flexor digitorum sublimis to digits IV. and V. (see p. 44). *Fl. d. p.*, flexor digitorum profundus. *Fl. c. u.*, flexor carpi ulnaris. *Fl. c. r.*, flexor carpi radialis. *A. p.*, abductor pollicis. *Fl. br. p.*, flexor brevis pollicis. *Fl. p.*, tendon of flexor profundus to pollex. *Lumbr.*, lumbricales.

PLATE IV.

Fig. 1. Fore limb Manis, outer side. *Tri.*, triceps. *Ext. c. r.*, extensor carpi radialis. *Ext. c. u.*, extensor carpi ulnaris. *Ext. d.*, extensor digitorum (1, 2, 3, 4; see p. 47). *Ext. i.*, extensor indicis, *Ex. p. pr.*, extensor pollicis primus. *Sup. l.*, supinator longus. *Trap.*, trapezius. *M. S.*, masto-scapular. *O. S.*, occipito-scapular.

Fig. 2. Hind limb of Manis, outer side. *S. tend.*, semitendinosus. *B.*, biceps. *P.* 1, 2, 3, peroneus primus, secundus, tertius. *Ext. br.*, extensor brevis. *Ext. h.*, extensor hallucis. *Tib. a.*, tibialis anticus. *Ext. d.*, extensor digitorum. *Gl.*, glutæus.

Fig. 3. *Ad. l.*, adductor longus. *Ad. m.*, adductor magnus inserted into inner condyle. *Ad. m′.*, portion of adductor magnus inserted into popliteal aspect of femur and connected with inner head of gastrocnemius. *S. membr.*, semimembranosus. *Gr.*, gracilis. *S. tend.*, semitendinosus. *Tib. p.*, tibialis posticus. *Tib. p′.*, tibialis posticus secundus. *Abd.*, abductor hallucis. *Ac.*, accessorius. *Fl. br.*, flexor brevis. *Fl. br.*, flexor brevis hallucis. *Fl. d.*, flexor digitorum. *Pl.*, plantaris. *S.*, soleus. *Gastr.*, gastrocnemius. *B.*, ischial part of biceps. *B′.*, femoral part of biceps.

Fig. 4. Palmar interossei in Manis. *Fl. c. r.*, flexor carpi radialis. *Ab. p.*, abductor pollicis. *Fl. br. p.*, flexor brevis pollicis. *Fl. br.*, flexor brevis minimi digiti. *Fl. c. u.*, flexor carpi ulnaris.

Fig. 5. Plantar interossei. *Ab.*, abductor hallucis. *Fl. br.*, flexor brevis hallucis. *P. l.*, peroneus longus.

SKETCHES TO A SCALE OF THE AUDITORY ORGANS OF CERTAIN COMMON MOLLUSCS. By GEORGE GULLIVER, F.R.S. (Pl. II.)

ALTHOUGH an excellent physiologist, after great pains in the attempt, failed to detect these parts, and then argued against their very existence, in spite of the positive testimony of many previous observers, no doubt now remains on this point.

The object of the present notes is to give illustrated measurements of the auditory organs and to show how easy it is to find them in some of our commonest molluscs. It is hoped also thus to invite the attention of pupils to a subject which, if duly prosecuted, would be likely to extend our knowledge of an important department of anatomy and physiology, and sure to afford most interesting objects for microscopic inquiry. Indeed, when we consider how beautiful they are, and how significant the rudimentary appearance of an organ of sense must be, we might expect to find these auditory sacs and their contents regularly depicted in our books of physiology and micrography; but, so far as I know, there are no original English engravings and measurements of them yet published.

These now presented were drawn by me, from nature, as guides for diagrams to illustrate Professor Humphry's lectures, and without any thought of publication, as they are merely original sketches of well-known objects, though I know not that they have ever been engraved to a scale of measurements. After this explanation to Dr Humphry, he concludes that they might prove useful in the manner already mentioned, and accordingly still requests me to draw up these notes as a description of the engravings to be inserted in the *Journal of Anatomy and Physiology*.

The unpleasant sliminess and contraction of the terrestrial gasteropods may be entirely prevented by drowning; and this is done by keeping them under water for about eighteen hours. In cold weather a day or two more might be better. I commonly put the animals into a small rummer, turning it round and excluding air from it underneath water in a basin, leaving the rummer with its rim downwards and the creatures thus

imprisoned and submerged. If not left there until quite dead, they are apt to contract and exude mucus while under dissection, but with the advantage of retaining the activity of their cilia. When finally killed by drowning slugs and snails will be found conveniently extended and incapable of exuding mucus. If desired the drowning may be hastened by using water purged of air either by boiling or the air pump.

Though of each species only one of the auditory sacs is here depicted, it must be understood that they regularly occur in pairs. And this is one reason why they may be so easily recognised. Of a gasteropod, dissect out the lower œsophageal nerve-ganglion, press it between a glass object-plate and cover, when the congeries of otoliths may be seen, sometimes even by the naked eye, always with the aid of a low magnifying power, and presenting the appearance of two white round spots. The auditory organs are symmetrical, about a fortieth of an inch apart, and so deeply imbedded in the ganglion as to be visible on either side of it, though most so on its lower part. Thenceforth they may be dissected under a lens, and the microscopico-chemical examination prosecuted.

The whole mass of these otoliths may appear by its heaving as if alive. This motion is caused by that of each individual stone, as may be well seen towards the circumference.

In small conchifers the auditory sacs may be easily found at or near the root of the foot. Teaze out the part a little, by the aid of needles, or use simple compression as already described; and the sacs may often be seen through the shell and its contents in minute species of this kind.

The oscillation or vibration of the otoliths in this order is as interesting a spectacle as in the other. Looking at both the sacs and oscillating otoliths of a conchifer in one microscopic field of vision, novices exclaim "how like a pair of bright eyes peeping up at you, and twinkling too."

Though physiologists regularly attribute this motion to the action of cilia lining the sac, and in immediate contact with the fluid in which the otoliths are suspended, such explanation seems to require further inquiry. The oscillation of a single large otolith or of a congeries of small ones is often seen, especially in Limnæus, to be very active when no cilia can be

detected. On the other hand, such delicate cilia as are depicted in Figs. 1, 2, and 3, are occasionally so observed here and there at indifferent parts of the sac as to indicate that it is thus lined throughout. But such an appearance of these very slender cilia it is difficult if not impossible to have all in focus at once; and this is the only point in which these drawings are rather to be considered as plans than exact copies of what was seen at one view under the microscope. The oscillation of the otoliths is like a greatly enlarged representation of those well-known molecular motions of minute inorganic particles described by Robert Brown; and certain it is that such vibrations may be presented by comparatively large objects, such as the microscopic calcareous crystals in the brain and in or on the spina ganglia of the sympathetic nerve of batrachia, and quite independently of any ciliary action, as I have more than once witnessed such motions of these crystals when they happened to get into the middle of a suitable fluid.

The otoliths are composed of carbonate of lime; they are transparent when small, regularly hyaline, smooth and shining, and refract the light like fat-globules. They grow bigger and bigger both in fishes and molluscs, as I infer from the great difference of size of the otoliths, according to the respective sizes of one and the same species of animal of these classes.

Any one looking at the remarkable difference, as shown in the Figures, between the character of the otoliths in conchifers and gasteropods might well expect equally remarkable and curious forms in other orders of the same class; and probably some interesting results may reward researches in this direction.

PLATE II.

Fig. 1. Auditory Sac of Ancylus fluviatilis. Average diameters: the individual otoliths $\frac{1}{4000}$th of an inch long, $\frac{1}{8400}$th broad; the mass of otoliths $\frac{1}{1777}$th; the sac to its outside $\frac{1}{400}$th, all of an inch.

Fig. 2. Auditory Sac of Limnæus stagnalis. Average diameters: of sac to outside $\frac{1}{145}$th; of the individual otoliths $\frac{1}{1600}$th long and $\frac{1}{4000}$th broad; of the mass of otoliths $\frac{1}{333}$d, all of an inch.

Fig. 3. Auditory Sac of Cyclas lacustris. Diameter of otolith $\frac{1}{500}$th, of the sac to its circumference $\frac{1}{200}$th, of an inch.

The figures are all drawn to the engraved scale, of which one-fifth of an inch stands for one two-thousandth of an inch of the micrometer-divisions.

NOTE ON THE ARRANGEMENT OF THE MUSCULAR FIBRES OF THE VENTRICLES. By PHILIP J. HENSLEY, M.D., *Fellow of Christ's College, Cambridge. Tutor and Medical Registrar at St Bartholomew's Hospital.*

THERE are some admirable dissections of Dr Pettigrew in the museum of the College of Surgeons, showing the arrangement of the muscular fibres of the ventricles. The general arrangement of these fibres can be readily made out by dissecting a heart properly prepared by boiling in the manner described. In some papers presented to the Royal Society, and published in the Philosophical Transactions, Dr Pettigrew has carefully described his dissections, and pointed out the spiral arrangement of the muscular fibres of the ventricle. In these papers, however, he does not appear to indicate any explanation of the rationale of this arrangement.

The description given by Henle in his work on anatomy does not differ from Dr Pettigrew's in any point important to my argument.

It is my object in the present paper to point out one of the purposes which this spiral arrangement of muscular fibres appears to serve. It may, I think, be granted that it is a natural assumption to make, that a muscular fibre, at any rate a striated muscular fibre, cannot contract beyond a certain limit,—that if in its uncontracted state it is of a certain length, then upon its most extreme contraction, it cannot be shortened by more than a certain definite fractional part of that length. We can imagine a muscular fibre contracting to one half or it may be one third of its uncontracted length, we cannot believe it possible for it to contract without limit, so that its length may become indefinitely short—we cannot believe that its length shall be *nil.*

Observation moreover of all the voluntary muscles of the body, that is to say, of those muscles specially whose contraction is accomplished with rapidity and precision, shows us that the variation of the lengths of the fibres between their

most extended and most contracted condition is not very great.

Also in those muscles which contract with the greatest rapidity and precision all the fibres, or at any rate all the fibres in the same neighbourhood, contract pretty nearly equally. In those muscles which are terminated at their insertions by narrow tendons this is of course quite obvious, since the distance between the points of attachment of the different individual fibres is about the same for all; and this distance is upon contraction lessened by about the same quantity for all.

Now the main object of the ventricular contraction is simply the emptying of the cavity of the ventricle; and to this end we might expect that the arrangement should be such that each individual muscular fibre should contribute its greatest possible quota, and that the action of each fibre should continue throughout the contraction.

It appears to me that the arrangement of the walls of the ventricle is such, that in order to completely empty the cavity, 1st, no fibre need contract beyond a certain limit, 2ndly, all the fibres may contract to about the same extent.

Imagine a cylindrical bundle of parallel elastic fibres inserted at their extremities into two circular plates of which the planes are parallel: then as these plates are made to approach one another without any rotation, the distance between the extremities of all the fibres is always the same, and therefore of course all the fibres are equally contracted.

Imagine further a layer of elastic fibres wound round this bundle in spirals or helices, and with their extremities attached to the edges of the plates.

If now the two plates be caused to approach one another without any rotation, and the straight fibres be supposed to continue straight and to form a cylindrical bundle, and the spirally arranged fibres still to proceed in spirals, but of course crossing the straight ones at a different angle, then these spiral fibres will be less contracted than the straight ones, that is to say, a given length of one of them will be less shortened than the same length of one of the straight ones, and they will be the less contracted the greater is the angle at which they cross

the straight fibres, or in other words the more rapid are the spirals they make.

We have here supposed that our bundle of straight fibres while it decreases in length does not alter in thickness: experiments, however, have been made tending to show, as might be expected, that as a muscle contracts its bulk does not alter, and if our supposed bundle of cylindrical fibres were to follow this law, its diameter would increase as its length diminished.

In such a case therefore the spiral fibres would be still less contracted than in the first supposed case, upon the approach of the plates to one another. In reality, however, these experiments are supposed on muscles in which there is no circulation going on, and so no blood to be pressed out upon contraction.

From the foregoing simple geometrical considerations, therefore, it may be concluded that if there be such a system as we have supposed formed of muscular fibres and the two plates are drawn together without rotation by their contraction, the spiral fibres will be less contracted than the straight ones; the spiral fibres, therefore, cannot be equally contracted without compressing the central straight ones, and such compression might be effective in pressing out the blood contained in the vessels supplying these fibres.

If there be another outer layer of fibres passing round the first set in more rapid spirals, and the whole system be equally contracted, then this outer layer will compress somewhat the inner one.

Imagine now that the extremities of the fibres of our cylindrical bundle are bent round and brought together to meet and become continuous, so that we have a system of fibres each of which is a circle, and the whole together form a ring of fibres like an anchor ring.

It is then clear that the central opening of this ring cannot be closed up by the contraction of the fibres until the innermost and shortest fibre is either contracted until its length is absolutely *nil*, or until it is irregularly compressed and puckered together by the action of the more external fibres.

If now endless spiral fibres be supposed to pass round this

ring through the central opening and out round the outermost circle of the ring always in contact with its surface, and there be several layers of such fibres, the first passing round in gradual spirals, the later ones more rapidly; then it may be inferred from what has been said before (although the geometrical consideration of this case is very much more complicated) that, if all the fibres circular and spiral contract equally, the circular fibres will be somewhat compressed by the first layer of spiral fibres, and these again by the outer spiral layers: it will also be seen that in order that the central opening of the ring may be closed up, it will not be necessary that any of the fibres contract beyond a certain limit.

If now the form of our ring of circular fibres, instead of being like an anchor ring, be more like the upper part of a funnel, and layers of fibres pass round it in and out, in spirals at first gradual but the most superficial more rapid, and there be a sufficient thickness of such fibres to completely fill up the opening at the smaller end of the funnel, we arrive pretty nearly at what is the actual formation of the ventricle of some of the lower animals, or what with some modifications is that of the human left ventricle.

If such a system were to contract it would seem that its funnel-shaped cavity would be gradually obliterated from its apex to its base, so that a progressive squeezing out of any contained fluid towards the base would be effected.

Of course the ventricles are not to be compared accurately to such a supposed system of fibres; the connexion of the ventricles with one another and with the auricles complicates the arrangement somewhat; still such is the general plan, and from what has been said it will be seen that with such an arrangement the ventricular cavity may be emptied by the action of all the fibres contracting about equally, so that each fibre may be in full action throughout the whole time of the contraction. This could not be the case if there were an arrangement of separate systems of inner and outer fibres; with any such arrangement, in order that the cavity might be emptied, it would be necessary either that the inner fibres should contract down to *nil*, or be compressed and puckered together by the action of the more

external layers, in which case they would of course be ineffective, except at the beginning of the systole.

Even with the cavity of the ventricle, partly occupied as it is by the columnæ carneæ, it would be necessary with any such arrangement that the inner layers should contract very much more than the outer.

One other point may be considered.

In the left ventricle the cusps of the valves are attached to the columnæ carneæ, and the fibres of the columnæ carneæ pass down to the apex, and then passing out to the exterior surface of the heart become continuous with the outer spiral muscular layers; these outer layers passing upwards and across dip round at the base to become closely connected with the upper margins of the valves.

Thus the valves with their attached muscular fibres form a system of spiral fibres with one non-contractile part: this system then of spiral fibres leaving one non-contractile part will always be on the whole somewhat less shortened on contraction than will be the complete spirals which pass round in the same way, and thus as the ventricle contracts, the two flaps of the valve will always be allowed to lie a little, but not very much, away from the inner walls of the ventricle: thus they will be sufficiently free to be in contact with one another, but retained at every instant in a definite position relatively to the walls of the ventricle.

ON CHIONIS ALBA. By R. O. CUNNINGHAM, M.D. (Edin.), *Naturalist to H. M. Surveying Ship, Nassau.* (Pl. VII.)

THE Sheath-bill, which has been known to ornithologists for a considerable time, having been first described, if I mistake not, by the celebrated Forster, has excited a considerable amount of interest from its peculiarities of form and habit, which have given rise to some difference of opinion as to the true position which it ought to occupy in the class of vertebrates to which it belongs. For in some points it appears to present affinities to some of the groups of *Gallinæ,* while in others, and among these specially its habit of life, it exhibits undoubted relations to certain of the *Grallæ.* Thus Mr G. R. Gray, in his magnificent and valuable work on the "Genera of Birds," makes *Chionis* the type of his fifth family of *Gallinæ,* which he accordingly entitles *Chionididæ,* or Sheath-bills, associating with it the curious South American genera, *Attagis* and *Thinocorus,* while another distinguished ornithologist (Prof. Newton of Cambridge), in consideration of its grallatorial characters, is, I believe, disposed to regard it as an aberrant *Hæmatopus.*

In respect to its geographical distribution it may be stated, roughly speaking, to be an antarctic bird, as it does not appear to extend northwards much beyond the southern extreme of the continent of South America, where it is frequently seen far out at sea as well as in the neighbourhood of Cape Horn. It also occurs, but in a very limited degree, in the Strait of Magellan, where I met with it once or twice; and a little to the north of this on the east coast of Patagonia, where I saw a single specimen at Port Gallegos in December 1867. In the Strait of Magellan I observed it near Dungeness Spit at the eastern entrance in November 1867, when several individuals made their appearance in the vicinity of the ship on board of which I then was; and from their flight and general aspect were not unnaturally mistaken for pigeons by those who first saw them; and a few weeks later I noticed several specimens on the small island of Santa Magdalena, a desolate spot, rarely

visited by human beings, and tenanted by sea-lions, penguins, and enormous numbers of cormorants.

Some months after I had seen the bird for the first time, I obtained two specimens of it, one shot on Dungeness Spit and the other on Santa Magdalena.

The *former* of these was unfortunately so heavily hit that the viscera were reduced to a condition verging on pulp; and a bad skin, together with the sternal apparatus, were the only parts worth preserving as fit for examination. These were accordingly sent, together with the other ornithological specimens collected, to the care of Prof. Newton, for the Museum of the University of Cambridge.

The *latter*, in all respects a better specimen. I placed in spirit, with the intention of making a complete dissection of the internal anatomy, but from various causes I delayed this much longer than I had intended, and it was not until the autumn of last year that I essayed to begin my task. I then found, however, that most of the soft parts had become so much contracted and hardened through their prolonged immersion in the spirit that a thorough and minute dissection was impracticable. I was, therefore, obliged to content myself with as careful an examination of the principal digestive organs as their condition would permit of, and the placing of the entire carcase in water with the hope of preparing an entire skeleton, which might enable me to draw up such a complete description of the osteology as would aid in the determination of the true affinities of the bird. But in this hope I was disappointed; for the bones were lost, to my great vexation, while undergoing the process of maceration. I have, therefore, only a few brief notes on the digestive organs to add to our knowledge of this very interesting form.

The specimen examined was a female. The *tongue* was rather thick and fleshy, and deeply hollowed out along the mesial line and at the apex. The entire length of the *Oesophagus* (including the proventriculus) was 6½ inches. It presented a well-marked enlargement which, though not materially differing in its structure from the rest of the tube, may be regarded as a modified crop. This crop was empty. The *stomach*, which contained small pebbles alone, was moderately

muscular, and its lining membrane was of an orange-yellow colour. Its long diameter measured $1\frac{3}{8}$ths of an inch, and its greatest transverse diameter $\frac{7}{8}$ths. The intestinal canal, from the pyloric orifice of the stomach to the anus, measured a little over 40 inches. The *cæca,* two in number and of equal size, measured 7 inches in length, and the distance between their origin and the anus was $2\frac{1}{2}$ inches. They considerably exceeded the diameter of the intestine at their extremities and tapered to their insertion into it, at which point their diameter was much less. They were filled with a grumous yellow substance.

I would merely add that the legs of *Chionis* present a decided resemblance to those of *Hæmatopus,* and that in my cursory examination of the sternal apparatus I thought that a relation to that genus was indicated, but on these points a much more competent authority (Prof. Newton) has the means of forming an opinion.

Fig. 1.—Tongue; 2, Oesophagus and stomach, the outer wall of the proventriculus removed to show the glands at a; 3, Cæca. All natural size.

NOTE OF A SUPERNUMERARY LOBE TO THE RIGHT LUNG. By JOHN CHIENE, M.D., F.R.C.S.E., *Demonstrator of Anatomy in the University of Edinburgh.*

IN addition to the constant secondary fissure separating the upper lobe of the right lung from the middle lobe, anatomists occasionally meet with a further, more or less complete, division of the primary lobes of the lung by means of additional branches from the great vertical fissure. This case is however different, in that the abnormal lobe is added to, not formed at the expense of the primary lobes. It occurred in a female, aet. 50, dissected in June 1869.

On raising the right lung, to demonstrate the passage of the pleura from the wall of the chest to the posterior surface of the viscus, a supernumerary lobe, lying between the upper lobe of the lung and the bodies of the dorsal vertebræ, was

exposed. It had its origin from the angle formed by the junction of the upper lobe with the root of the lung. It was pear-shaped, 3¼ inches long, 2 inches broad at its widest part, 1 inch at its junction with the mass of the lung. It occupied and completely filled when inflated a cul-de-sac lined with pleura. The length of this sac was 3 inches, the breadth 2 inches. The opening into it admitted two fingers, and was bounded anteriorly, externally, and posteriorly by the vena azygos major, contained in a duplicature of the pleura, and internally by the bodies of the vertebræ; it resembled in size and appearance the foramen of Winslow, the vena azygos, in its relation to the serous membrane, being analogous to the structures between the layers of the lesser omentum. The supernumerary lobe was separated from the upper lobe of the lung by a double fold of the pleural membrane, which descended vertically for 2½ inches from the apex of the thoracic cavity, where it was continuous with the pleura costalis; it enclosed in its free lower border the vena azygos, and formed the outer wall of the cul-de-sac, in which the supernumerary lobe was contained.

In its general arrangement the septum might be compared to the falx cerebri, the vena azygos to the inferior longitudinal sinus, the upper lobe and supernumerary lobe to the hemispheres of the cerebrum. The vena azygos left the wall of the chest opposite the body of the fifth dorsal vertebra, and passed, as already described, in a curved direction round the root of the supernumerary lobe to join the vena cava superior in the usual position: from the free lower border of the septum to the bifurcation of the trachea measured two inches. The left side of the chest was normal; both sides were healthy.

ON THE CHEMICAL COMPOSITION OF THE NUCLEI OF BLOOD CORPUSCLES. By T. L. Brunton, B.Sc. M.D. *Late Senior President of the Royal Medical Society of Edinburgh.*

During the course of last summer Professor Kühne discovered that the chief constituent of the Nuclei of Blood Corpuscles agreed in its reactions with mucin rather than fibrin or albumen. It had previously been found by Hoppe Seyler[1], associated in the nuclei with a small amount of paraglobulin, and previous to Professor Kühne's discovery, had been supposed to be an albuminous substance, resembling fibrin. I was informed by Professor Kühne while working in his laboratory in Amsterdam of the observations he had already made, and having repeated them, I publish the result with his permission. The observations are not complete, but I give them now as I am unable to prosecute them further at present.

The nuclei of the blood corpuscles of eels and frogs yield a substance similar to that obtained from the blood of fowls; but as the latter could be much more readily obtained in considerable quantity, it alone was used in studying the reactions in detail.

To obtain the nuclei, the defibrinated blood, mixed with ten or twelve times its volume of NaCl solution of 3 per cent. is filtered through linen, and the corpuscles allowed to subside in a flat tray. The supernatant fluid is then removed by a syphon, and the corpuscles, thus freed from serum, are either washed repeatedly with much water in the same manner, or after being allowed to settle in the salt solution for at least twenty-four hours, when they form a kind of film, are scraped together and washed on a linen filter. In the former case the nuclei or rather zooids of the blood corpuscles are obtained as a white powder which sinks very slowly in water, in the latter, as a mass resembling fibrin in appearance. Microscopic examination shows this powder to consist of the nuclei in the form of small round bodies containing several

[1] Kühne, *Lehrbuch der Physiologischen Chemie.*

dark granules, surrounded by a ring of transparent colourless substance, apparently a remnant of stroma, whose breadth is about equal to the diameter of the nucleus, and whose edge is so delicate as to be scarcely perceptible. On the addition of aniline, red or blue, dissolved in dilute alcohol, the nucleus becomes deeply coloured, the stroma slightly so, and its edges much more distinct. Weakly alkaline solutions of carmine and solutions of iodine also colour the nucleus deeply, but the stroma very slightly or not at all. The nucleus is generally in the middle, but, occasionally, is more or less eccentric, and sometimes sticks quite close to one side of the surrounding substance. This last may possibly be its constant situation, and its central one only apparent, and it may thus correspond to the point in mammalian blood corpuscles, which was found by Roberts[1] and Rindfleisch[2] to become deeply coloured by magenta. If the powder be then shaken with ether and water it forms a layer between the two; and when this is microscopically examined, the nuclei alone are seen, the stroma formerly surrounding them being no longer perceptible even after the addition of aniline. The nuclei may be got at once by treating the corpuscles with ether, separating the nuclear layer by a stoppered funnel and then washing in water. Alkalis cause the nuclei to swell, to run together in clumps, become indistinct, and finally disappear. Dilute mineral acids or acetic acid cause them to shrink and become more sharply defined. A small strongly refracting point resembling a nucleolus and seeming to take up the colouring matter more strongly than the rest also becomes visible; but this appearance may be due to a change of shape in the nucleus, occasioned by the acid. Concentrated mineral acids cause them to shrink much, to run together, become indistinct and disappear. The stroma surrounding the nuclei swells and shrinks somewhat but not so markedly as the nuclei. If ferrocyanide of potassium be added to the nuclei shrivelled by acetic acid they swell up and become so indistinct as to be hardly visible. A solution of taurocholate or glycocholate of soda dissolves both nuclei and stroma. A little concentrated NaCl solution also causes the nuclei to disappear.

[1] *Proceedings of Royal Society*, 1863.

[2] *Experimental studien über die Histologie des Blutes.*

When the corpuscles are washed on a linen filter, a fibrinous looking mass is obtained, which, on microscopic examination, is seen to consist of shreds of fibrous membrane or of bundles of fibres, studded with darker spots and arranged in a manner resembling those of fibrin though more regular and with less intercrossing. These spots seem to be the nuclei, but their outline is not so distinct, nor do they take the deep tint with aniline which they do in the powdery condition, the fibres becoming quite as deeply tinted as they.

The zooids are insoluble in water, and when suspended in it sink very slowly, but do so much more quickly after the addition of alcohol, concentrated acetic or oxalic acid, or dilute mineral acids. The mixture with water is quite mobile and does not foam when shaken, but does so after the addition of a little NaCl solution, becoming at the same time somewhat tenacious and much clearer, the nuclei being partly dissolved and partly suspended. A concentrated mixture with NaCl solution gives a white flocky precipitate when much diluted. Salt solutions of even one-fourth per cent. dissolve them to a considerable extent. The solubility in NaCl solution varies much, diminishing when the zooids stay long in water, but more slowly when the temperature is low. The same is the case with mucin obtained from tendons. When many zooids are suspended in water, one drop of concentrated solution of potash or soda is sometimes sufficient to convert 40 cubic centimetres of the mixture from a milky mobile liquid to a clear gelatinous mass, resembling albuminate of potash in appearance though not quite so firm. When this is thrown on a filter the filtrate gives no precipitate with acetic acid. When more potash is added, a tenacious ropy fluid is produced which filters very slowly, the filtrate is mobile, and though generally more or less alkaline, is sometimes neutral. Alkaline carbonates dissolve them but much more slowly, nor do they form a jelly like the caustic alkalis; sometimes, however, they cause the zooids to stick together and form flocks, which, rising to the top, form a sticky mass. Lime and baryta water leave them apparently unchanged, and after standing on them some time, give no precipitate with acetic acid, but an immediate turbidity if ferrocyanide of potassium be then added. Concentrated mineral

acids dissolve the zooids and give a precipitate on the addition of alkalis or much water.

Dilute mineral acids, such as HCl of 10 per cent., cause the mixture with water to foam on shaking, but when the filtered fluid is made alkaline by potash it gives no precipitate with acetic acid but a turbidity when ferrocyanide of potassium is then added. The filtered solutions of the zooids in alkalis give the reactions of albumen, but the precipitate by acetic acid is generally insoluble in excess. Sometimes, however, not only the mucin from nuclei but that from glands and tendons appears quite soluble in large excess of glacial acetic acid. If the zooids be treated with ClH of $\frac{1}{10}$th per cent. or acetic acid or NaCl solution of 10 per cent. and the filtered solution be precipitated by acetic acid and again filtered, the clear fluid in each case gives the reactions of albumen. The HCl solution is precipitated on neutralization and the precipitate is insoluble in NaCl solutions of 10 per cent. The albuminous body thus belongs to that class which includes, according to Hoppe Seyler, fibrinogen, fibrinoplastic substance and myosin. That the zooids contain fibrinoplastic substance or paraglobulin, as stated by Hoppe Seyler, is shown by the distinct fibrinoplastic action which they exert when well washed. Sometimes they possess none at all; and this is probably due to the removal of the substance in the washing, the salt solution with which the corpuscles were washed not having been sufficiently carefully removed and rendering the first water a dilute salt solution which dissolves a certain amount both of albuminous substance and of mucin, becomes milky after standing or passing CO_2 through it and possesses a slight fibrinoplastic effect. The fibrinoplastic effect was tried in all cases with a mixture of horse plasma and sulphate of magnesia. From the way in which fibres are formed when the zooids are washed on a linen filter it seems probable that fibrinogenic substance may also be present; but whether this be the same as mucin or what the relation between mucin and the generators of fibrin or myosin, if any such relation exists, is still to be investigated. When the precipitate from solutions in alkalis or NaCl by acetic acid is washed with acetic acid, then with dilute alcohol and afterwards dissolved in a *small* quantity of potash and filtered, the filtrate is generally

alkaline but sometimes neutral. It is unchanged by boiling, gives with mineral acids a precipitate soluble in excess, and with acetic acid a precipitate insoluble in excess. On exceptional occasions, I have seen it as well as mucin from tendons dissolved by excess of glacial acetic acid give with acetic acid and ferrocyanide of potassium no turbidity, the ferrocyanide of potassium causing any turbidity from the acetic acid to become less and disappear; but after standing a considerable time a precipitate forms. Chloride of mercury causes no precipitate; with tannin acetate of lead or dilute sulphate of copper or chloride of iron it gives a precipitate. Added to potash and sulphate of copper it prevents the precipitation of the hydrated oxide of copper, but the solution remains blue even after boiling.

Nuclei freed from stroma by ether and water and then dissolved in potash give the same reactions. These reactions differ from those of mucin as given by Eichwald, (Kühne, *Lehrbuch der Physiologischen Chemie,*) inasmuch as tannin, sulphate of copper and chloride of iron give a slight precipitate or turbidity, but on treating nuclei and mucin from glands and tendons in the same way they gave the same reactions. When a salivary gland is treated by potash and the solution precipitated by acetic acid, the precipitate is sticky and seems to differ much from that given by acetic acid in solutions of nuclei in potash which is flocky, and gathers on a linen filter into a mass looking like boiled fibrin; but if the strongly acid and sticky precipitate from the gland be allowed to stand some time in water it becomes exactly like that obtained from the nuclei. The zooids and their solution in NaCl act briskly on peroxide of hydrogen; the nuclei after treatment by ether and water do so also but less vigorously. When boiled with dilute sulphuric acid they gave no trace of sugar. I have never succeeded in obtaining them free from sulphur even after repeatedly dissolving in potash, and precipitating and washing by acetic acid; but the more carefully they were cleaned the less sulphur was found; and Professor Kühne on one occasion obtained no trace of sulphur after burning with nitrate of potash and adding chloride of barium. This trace of sulphur may possibly depend on a little albumen carried down with the mucin; more especially as one sees that if the homoglobin be not entirely

removed by washing before dissolving in potash and precipitating by acetic acid, hæmatin is constantly carried down with the precipitate and cannot again be separated. When chicken blood is treated by NaCl solution of 10 per cent., as in Professor Heynsius' experiments lately published, the nuclei are dissolved and form a large portion of the fibrinous looking substance he describes. Whether mucin exists in mammalian blood or not I cannot certainly say, though the substance got by treating dogs' blood with salt solution of 10 per cent. and then washing the slimy mass seemed, after solution in potash, to give a precipitate with acetic acid insoluble in excess. The quantity obtained pure was however so small that I was unable to try any other reaction.

Shortly then, the substance of the nuclei, both with and without the stroma, agrees with mucin and differs from albumen in its insolubility in HCl of 0·1 to 1 per cent., in its alkaline solutions being precipitated by nitric, hydrochloric, or sulphuric acid, and the precipitate dissolved without difficulty by excess; in being precipitated by acetic acid and the precipitate insoluble in excess, ferrocyanide of potassium causing no further turbidity but clearing up any formed by the acetic acid; in neutral solutions being unchanged by boiling and giving no precipitate with chloride of mercury, and when boiled with caustic potash and sulphate of copper remaining clear blue. It agrees with albumen and with mucin as I found it (though differing from it, as described by Eichwald) in giving a turbidity or slight precipitate with tannin, chloride of iron and sulphate of copper. It differs from mucin in being insoluble in lime or baryta water or in HCl of 10 per cent. Its most remarkable reaction is the change it undergoes by the addition of a very small quantity of caustic potash to the water in which it is suspended. It is then much more closely allied to mucin than to albumen. From the solubility and reactions of mucin being somewhat variable it is not improbable that, like albumen, it may occur in several forms of which this may be one; but its composition and relations must be determined by analyses which I hope at a future period to be able to make.

ON THE DISTAL COMMUNICATION OF THE BLOOD-VESSELS WITH THE LYMPHATICS; AND ON A DIAPLASMATIC SYSTEM OF VESSELS. By Thomas Albert Carter, M.D. (Edin.), M.R.C.P.; *Physician to the Leamington Hospital and the Warwick Dispensary.* Pl. v. vi.

[The following paper is a *verbatim* copy of one presented to the Royal Society of London in April, 1864. It was illustrated with seventeen coloured drawings, and was accompanied by the microscopic preparations from which the drawings were made. A short abstract appeared in the "Proceedings," June 16 of the same year. I have added in the form of footnotes in brackets some additional remarks where they seemed to be required. T. A. C.]

My attention was first directed to the investigation of the origin of the lymphatics in the early part of 1861 by observing that the liver of one of the lower animals, which I had injected from the portal and hepatic systems, exhibited on its surface the lymphatic network very perfectly distended with the two pigments which had been employed. A similar phænomenon has not, I believe, been unfrequently witnessed by anatomists when injecting the blood-vessels, but the circumstance has been accounted for by supposing that rupture of some arterial or venous twig had taken place, and that the injection had thus gained entrance to the lymphatic system. This, indeed, I regard as the true explanation of the filling of these vessels from the sanguiferous system, or from the ducts of glands when finely divided mineral matters, such as vermilion or chromate of lead, have been used; but in the case to which allusion has just been made, and which will be entered upon in detail hereafter, an explanation of this kind I consider to be totally inadequate. Suffice it here to say, that the conclusion arrived at from the careful and prolonged examination of thin sections taken from this liver and from others subsequently injected, was that direct communication exists between the lymph vessels and those of the blood at their distal as well as at their proximal extremities, and in the former position through tubes of dimensions so small as to preclude the possibility of the blood-corpuscles entering them. From the time my first observations were made on this subject until now (1864) I have been engaged in accu-

mulating further evidence of this communication, and in doing so I have been led to the discovery of another system of vessels, not connected apparently[1] with the lymphatics, but commencing and terminating in the capillaries, and resembling those before-mentioned in being so minute as to admit of the passage only of the liquor sanguinis.

Before entering upon my own special investigations, it will be advisable to narrate briefly what has been said, and more important still, what has been done by modern labourers in this field of inquiry, or, at any rate, in those which border closely upon it.

It will scarcely be necessary for me to canvass the opinions of the older authors respecting the origin of the lymphatics, knowing as we do that to cope with questions so delicate as this the most modern appliances are required. I therefore entirely refrain from quoting opinions which must, from the nature of the case, have been based upon observations of an unavoidably imperfect character.

So long ago as 1845 Mr Goodsir directed[2] special attention to certain corpuscles which had been previously noticed by anatomists in some of the textures, but which had up to that time been looked upon for the most part as the remains of embryonic life. Mr Goodsir, however, discovered that such corpuscles are common to all textures and organs and to all stages of existence, and hence concluded that their functional importance in the animal economy must be very great. To use his own words he believed them "to draw from the capillary vessels, or from other sources the materials of nutrition, and to distribute them by development to each texture and organ after its kind." In accordance with this view he named these corpuscles "centres of nutrition," or, following the nomenclature of the embryologists, "germinal spots." He further defined a nutritive centre as "merely a cell," the nucleus of which is the permanent source of successive broods of young cells" (*Anat. and Path. Obs.* p. 2, 1845); and he held the nuclei of muscle, the cells of areolar tissue, and the corpuscles of bone to be ex-

[1] [i. e. as far as could be actually seen. 1869.]

[2] [*Anatomical and Pathological Observations*, 1845. *Anatomical Memoirs*, Vol. II. Edinburgh, 1868.]

amples of these centres. The branching processes or canaliculi of the bone cells he regarded as "channels for the passage of nutriment from the capillaries to the calcigerous cells and germinal centres" (*Ibid.* p. 66); and the tubules of dentine have also long been supposed by anatomists to perform functions similar to the canaliculi of bones, of which indeed they would seem to be but modifications, and with which they are often in direct communication. A canalicular or juice-carrying system of vessels was thus early recognised as appertaining to the hard tissue of bone and tooth. In 1851, however, Virchow (*Würzburg Verhandl.* Bd. 2, s. 159), and about the same time Donders (*Zeit. für Wissen. Zool.* Bd. 3, p. 348) and Von Wittich (*Würzburg Verhandl.* Bd. 2, 1851), observed that the corpuscles of white fibrous, or connective tissue, were generally of stellate form, and possessed delicate prolongations which anastomosed freely with those of neighbouring cells. From this observation, and probably bearing in mind the relation which white fibrous tissue bears to bone, Virchow was led to believe that the network thus formed is tubular throughout, and employed in the distribution of nutritious juices to the surrounding textures; Kölliker too (*Elements d'Histologie humaine*, Paris, 1856, p. 73), falling in with Virchow's ideas, has denominated these cells and their prolongations "plasmatic cells" and "tubes" respectively; but neither of these authors has, as it appears to me, brought forward any direct evidence of the correctness of their surmises. Virchow believes this "juice-canal-system" to be entirely unconnected with the blood-vessels (Virchow's *Cellular Path.* p. 94, by Chance), and in no way similar to the supposed "vasæ serosæ" of the older anatomists; he believes it, if I understand him rightly, to be essentially a closed system of vessels. Leydig, on the other hand, supposes that the prolongations of connective-tissue corpuscles are continuous with the lymphatic vessels, and he has given in his *Lehrbuch der Histologie*, p. 403, 1857, a diagrammatic representation of his views. Recently he has gone further[1] even than this, and from examinations he has made concerning the relationship of the blood-vessels to the connective-tissue in various organs, he thinks it "possible" that an open communication exists between the

[1] So stated by Von Recklinghausen in *Die Lymphgefässe.*

blood-vascular and lymphatic systems. One of the latest writers on this subject, Von Recklinghausen[1], affirms that he has been able to trace the continuity of the juice-canals with the finest lymphatic vessels in those organs which he has subjected to examination. Opposed to the views of Leydig and Von Recklinghausen are those entertained by the majority of anatomists who, as is well known, hold that both the lymphatic and blood-vascular systems are closed and unconnected at their distal terminations; and recently Schweigger-Seidel and Teichmann have, as they imagine, proved by injection that the walls of the lymphatics are impermeable even to the finest pulverised substances, and that no direct passage exists between the uninjured blood-vessels and the uninjured lymphatics (*Med. Chir. Rev.*, July 1863, p. 232). Such then is a brief statement of the contradictory views held by the more modern inquirers who have given their attention to the origin and connexion of the smallest lymph-vessels. Were I to attempt a critical analysis of the various papers written on this subject, it would render this communication unnecessarily long. I shall therefore now proceed to describe my own methods of research and the results which I have obtained, leaving these results either to contradict or confirm the statements, which have hitherto been made, regarding the anatomical relations of the minutest lymphatic vessels.

As the results which I am about to record possess something of novelty and will therefore raise doubts touching their accu-

[1] *Die Lymphgefässe und ihre Beziehung zum Bindegewebe*, 1862.

[Recklinghausen however attaches a different meaning to the term 'juice-canals' than do Virchow, Kölliker and Leydig. With them the connective tissue corpuscles are the juice-canals. But with Recklinghausen the juice-canals form a system of inter-communicating spaces, having a free communication with the lymph vessels, which surround and enclose the corpuscles of the connective tissue. Moreover he does not think that these canals are tubes with special walls, but excavations as it were in the connective tissue. Neither does he agree with Brücke and Ludwig in conceiving them to be mere interstitial spaces, for he believes that the fibrous bundles and lamellæ of the connective tissue are cemented together by a homogeneous, firm material in which the juice-canals are situated. In an article on the lymphatic system, which has just appeared in the 2nd part of Stricker's *Handbuch* (Leipzig, 1869), Recklinghausen states, in opposition to the opinion he formerly entertained, that he now thinks it possible that the juice-canals have an open communication both with the blood and lymph vessels; and he refers to some recent experiments by Dr Rud. Böhm, made by the application of nitrate of silver to the synovial membrane, which seem to show a similar passage of the juice-canals into the blood-capillaries. **Note, October, 1869.**]

racy in many minds, it will be well to give some account of the method followed and the materials employed in these researches, so as to avoid all unnecessary discussion and scepticism founded on erroneous suppositions.

Whatever success I may have attained to in the present inquiry, I consider to be almost solely attributable to the use of transparent injection of extraordinary penetrating power, consisting of carmine precipitated in gelatine from its ammoniacal solution by acetic acid. The formula for this injection I published in Beale's *Archives of Medicine*, No. xii. 1862. Besides its valuable penetrating qualities it possesses intense brilliancy of colour, and does not stain the textures with which it may come in contact. I insist especially upon this latter property, because many of the carmine vascular preparations with which the public are now familiar, exhibit decided evidence of the pigment having permeated the coats of the vessels and tinted the surrounding tissues,—a knowledge of which circumstance might act prejudicially against the acceptance of my conclusions. I do not deny, however, that under certain very exceptional conditions of the blood, as, for example, great alkalinity, staining of the texture may to a slight extent occur, but such staining will by the experienced eye be easily recognised. The distinguishing characteristic of tinting by the carminate of ammonia is that the nuclei of the tissues become much more intensely coloured than the cells or fibres; but carminic acid, as it exists in my injection, produces no such effect upon the nuclei.

Occasionally, during my investigations, I have resorted to another transparent injection. This was made by precipitating Turnbull's blue (the ferrid-cyanide of iron) in gelatine, and then slightly acidifying the mixture with acetic acid. Like the carmine injection this also is very penetrating, but it is not so much to be depended on in consequence of the rapidity with which the blood and tissues exert a decolorising influence on it. The colour, it is true, may be restored by the application of an acid, but I have found that in its colourless condition it is both soluble and diffusible. If, therefore, the tissues outside the blood-vessels have been impregnated with the iron salt, a blue tint will be developed in them also by the

action of the acid, and the preparation thus rendered useless for purposes of observation. With the view of avoiding the alkalinity generated by post mortem changes, I have, in every available instance, injected the animals immediately after death, i.e. as soon as respiration had entirely ceased. In the case of the human subject this of course could not be accomplished. I now enter upon the subject proper of this paper.

If a young frog be killed and the palate, after having been dissected from the base of the skull be examined with a quarter inch objective, the first thing that strikes the observer is the motion of the cilia; on focussing a little deeper the large epithelia to which the cilia belong are brought into view, and still lower are seen the capillaries with the contained blood-corpuscles. If the membrane be now macerated in water for a short time and brushed gently with a camel's hair pencil, a thick layer of viscid mucus will be removed, and with it, in some parts, the ciliated epithelial cells. On re-examination it will be found that the membrane presents a honey-combed appearance in those parts from which the superficial cells have been detached, but by focussing deeper there is brought into view a number of finely granular nucleated cells, possessing for the most part three divergent processes which anastomose with the corresponding processes of neighbouring cells, and in this way form a network. In the centre of each mass may be seen the nucleus of a cell, which lies on a somewhat lower level than the nuclei of the granular network. From this then it follows that in the mucous membrane of the frog's mouth three distinct layers of cells are recognisable, first, the ciliated epithelium, next, the granular cell-network, and last, globular nucleated cells, Pl. V. fig. 1. Upon this lowest layer rests directly the ciliated epithelium, so that the network occupies the space intervening between the superficial and deep layers, and also the space existing between the cells of each separate layer. This description will be better understood by referring to Pl. V. fig. 2, which represents a profile view of a fold of the urinary bladder of the frog, where a similar arrangement of parts presents itself.

From this drawing it will be seen that the processes of the cell-network extend not only in the horizontal, but also in the vertical direction, passing upwards between the surface layer of

cells as well as downwards between the cells of the basement layer. How the vertical processes terminate either above or below is not shewn in the drawing, nor can this be made out satisfactorily unless other modes of preparation are resorted to.

So far as I am aware the network just mentioned has hitherto been entirely overlooked by histologists with the exception perhaps of Burckhardt[1], who describes three layers of cells in the mucous membrane of the urinary tract in man, the middle layer consisting, he says, of caudate and variously branching cells the processes of which lie perpendicular to the surface. His second layer I strongly suspect corresponds to the second layer which I have noticed in the buccal and vesical mucous membrane of the frog, and which I shall now proceed to shew is both tubular and pervious throughout; and I hope furthermore to demonstrate that this network is in actual communication with the blood-vascular system, and from that system derives its supply of fluid.

How I came to a knowledge of this very singular and important fact I will now relate. In the early part of March 1863, a full-grown female frog, which I had kept in a glass jar from the previous October, from some unascertained cause died. Knowing that this animal had had no food while in my possession, and inferring from this circumstance that the tissues would be in a very relaxed condition, I thought it would afford a good opportunity for observing if the lymphatics could be filled with injection conveyed through the blood-vessels. I accordingly introduced an injecting pipe into the aorta of the previously warmed animal, and fully distended the vessels with the preparation of carmine and gelatine. On examining the membranes of the palate with a low power, after the removal of the mucus, I perceived an exceedingly delicate but perfectly regular carmine-coloured network lying in the interspaces of the capillaries. My first impression was that extravasation had taken place and that the reticulated appearance was due to the injection having insinuated itself between the superficial epithelial cells of the part. On subjecting the preparation, however, to more minute scrutiny under the quarter of an inch object-glass, it became per-

[1] Virchow's *Archiv*, Band 17, Hefte 1 and 2, p. 94.

fectly evident that this explanation was untenable, the network being as well defined and distinct under the high power as the capillary network was under the low one. Thus magnified, the nuclei of the lowest layer of cells were clearly defined, the centre of each mesh being occupied usually by a single nucleus, and the whole structure forcibly reminding one of Henle's[1] drawing of the wall of an air vesicle of the human lung which had been injected and afterwards tinted with carmine. In the less perfectly injected portions of the palate the junction of the cell-network with the capillaries could be readily observed. The communicating branches were here seen to arise chiefly, though perhaps not entirely, from certain bulgings noticeable in the capillaries of this structure. Although my preparation exhibited most satisfactorily the source from which this minute network derived its supply of fluid, I was unable to determine with certainty into what vessels the fluid was again emptied. Considering the small size of the channels of the cell-network as compared with the blood-corpuscles lying in the capillaries close by, and the impossibility of such corpuscles entering the network, it became evident that the liquor sanguinis alone could be admitted; considering further that liquor sanguinis is but lymph in a state of concentration, I was led to believe that I had obtained an unequivocal demonstration of the distal union of the blood-vascular with the lymphatic system. I must confess, however, that being unable to recognise any lymphatic trunks arising from the network, I am not prepared to assert that in this instance I have given sufficient proof of the intercommunication of the two systems. Nevertheless, in support of this idea, I may be allowed to mention that the lymphatic hearts situated on the lower part of the dorsum of this animal were filled with the injecting fluid diluted apparently with lymph, but by what route the injection gained entrance to these receptacles I am not in a position to state.

That the network communicates freely with the capillaries at numerous points even in a single mesh, is perfectly certain; it is therefore by no means improbable that it may both commence and terminate in the capillary vessels, thus constituting what might be styled an intercapillary plexus. Certainly if all

[1] *Handbuch der Anatomie des Menschen*, Bd. 2, p. 283.

theoretical considerations were laid aside and an opinion founded solely upon what could be seen in my preparations, the network would have to be regarded as absolutely intercapillary; but notwithstanding the extensive and seeming exclusive connexion of this plexus with the blood-vessels, I am not as yet inclined to give up simply upon negative evidence the possibility of its being united also with the lymphatic system, at certain points which have at present eluded my observation. Be this as it may, the very existence of a network communicating directly with the blood-vessels, and yet lying above the site of the so-called basement membrane, is of itself a fact, I think, of the highest interest for the physiologist. The relation which the channels of this network bear in point of size to the capillaries and blood-corpuscles may be ascertained from the following table. The measurements were taken from an injected palate which had been soaked in glycerine and acetic acid and subsequently mounted in preservative gelatine.

Capillaries........................from	$\frac{1}{2000}$ to $\frac{1}{1000}$ of inch.
Blood-corpuscles, trans. diam. from	$\frac{1}{1400}$ to $\frac{1}{2000}$ of inch.
Network (diaplasmatic) ......from	$\frac{1}{4300}$ to $\frac{1}{8600}$ of inch.

A comparison of the measurements will suffice to shew the correctness of what I previously stated respecting the impossibility of the blood-corpuscles entering the cell-network.

I am inclined to apply the term diaplasmatic at least provisionally to this nucleated network, as well as to the minute vessels to be hereafter mentioned, which connect the capillaries with the lymphatic radicles. In both cases the networks are pervious and will only admit the liquor sanguinis or blood-plasma. This term therefore appears to be sufficiently expressive of their character.

Since my first successful injection of the frog's palate, I have made numerous similar experiments in a like direction and very frequently with the same positive results. This network, it must be understood, is by no means confined to the mucous membrane of the mouth. I have traced it by means of injection down the whole length of the œsophagus and even into the stomach; and I have also seen evidence of it in the large intestine and bladder of the frog. The network may likewise be

injected in parts of the toad corresponding with those which I have just mentioned. The most perfect indeed of all my preparations of the cell-network was obtained from the mucous membrane of the eyelid of a toad which was injected immediately after death. I need not, however, stop to describe this plexus inasmuch as it presents a character precisely similar to that which is observable in the roof of the frog's mouth. I may say, indeed, that the network is of uniform appearance in all those parts to which I have hitherto alluded. In the lungs of the toad the network appears to be somewhat modified and developed to a very limited extent; but I have succeeded in proving by injection that vessels exist in these organs which are much smaller than the capillaries, and which are incapable of admitting the corpuscles of the blood. Such vessels may be seen in my preparations as represented in Pl. v. fig. 3, emerging sometimes from the sides, sometimes from the inner surface of the capillaries, and either extending from blood-vessel to blood-vessel completely across the mesh, or as is more commonly the case, traversing it for a short distance only and then terminating in a finely pointed or rounded extremity. The course taken by these vessels is seemingly always between the faint nuclei and cells which stud the mucous membrane of the air vesicles. As I think it probable that many persons on examining the drawing or the preparation from which it was taken, may be disposed to believe that the minute emergent processes which have been filled with injection, are nothing more than developing blood-capillaries, it is but proper to mention that the toad which furnished the preparation was quite full-grown; and was indeed one of the largest I have ever seen.

After having injected a very large number of frogs and toads and in every instance carefully scrutinized their integuments for evidence of the cell-network, I must admit that I have not yet obtained a demonstration which I should consider capable of convincing a sceptical person of its existence in this structure. Nevertheless, certain appearances (discarding analogy), have led me to suppose that such a plexus does exist in the skins of these batrachians[1].

[1] Quite recently (April, 1864), I had convinced myself by several different modes of preparation that a nucleated network was present in the epidermic

During the early part of the summer of 1863 I made several attempts to fill the blood-vessels of fishes with the carmine injection, and I at length so far succeeded with a small perch as to display the capillaries distributed over its scales as well as those supplying the pectoral fins. In several parts of the membrane uniting the fin-bones there could be seen, when the $\frac{1}{4}$ inch objective was used, a tolerably regular and beautiful network bearing a close resemblance to that found in the frog's mouth, but differing from it in being much more minute (see Pl. VI. fig. 4). As in the frog's plexus, so likewise in this, a nucleus could be recognised occupying the centre of each mesh.

Although my efforts towards demonstrating the diaplasmatic network in the proper epidermal portions of the skin of man and the other mammalia have not been so satisfactory as could be desired, I have so far succeeded in this direction as to have injected it in the base of the hair bulbs of some of the lower animals and more frequently in the parietes of the hair follicle. As yet I have only detected the network in the roots and follicles of the large whisker hairs of the mole, mouse and kitten. In these parts each mesh is occupied by a single globular nucleated cell[1].

Up to this point I have drawn attention to an extremely minute vascular system which is in direct communication with the blood-vessels but which on account of its minuteness can only be supplied with as it were filtered blood, *i.e.* blood minus the corpuscles; and in all the illustrative examples I have yet brought forward, the plexus has been confined to the mucous

layer of the skin of the palm of the hand. The larger nucleated swellings occupying the space between two or more contiguous cells, while the branches slant very obliquely upwards and downwards between the superimposed cells.

The plexus is more fully developed in the lower epidermal layers than in any other parts.

As I have not been able to prove the network to be in communication with blood-vessels, I have not thought it proper to insert these remarks in the body of the paper, or necessary to describe the particular method employed in exhibiting the plexus.

[1] Since writing the above I have been fortunate enough to discover in an injected preparation of the human tongue a network homologous with that of the frog's mouth; but confined, so far as I have yet been able to prove, to the inner surface of the tonsil-like mucous follicles situated at the posterior part of the dorsum of this organ. In aspect this plexus is very similar to that found in the buccal cavity of the frog, but it is of course of much greater minuteness. From it I have seen arise certain irregular vessels which must, I think, be looked upon as the lymphatics of the part.

membrane and skin, and to that particular portion which lies to the outside of the so-called basement membrane. Now, however, I shall proceed to shew that similarly minute vessels are to be met with in the deeper parts of the organism, as in the nervous, muscular and osseous tissues, and in certain glands; and I shall furthermore attempt to shew that as on the one hand the networks are connected with the blood-vessels, so on the other they communicate with the lymphatics—I hope at least to be able to prove this distinctly in several well marked instances.

The human liver, as well as the liver of the pig, is largely supplied with lymphatic vessels, and both are well adapted for exhibiting the general character and arrangement of the minuter branches of this system of vessels. As these organs have, moreover, in my hands given the most decisive proofs of the intercommunication of the blood- with the lymph-vessels I would specially recommend them to the notice of those who may wish to test the accuracy of my statements. I have now injected the portal and hepatic vessels of three human livers, and of the livers of three pigs, and in each instance the superficial lymphatics were distended with injection of a colour resulting from the admixture of the two pigments employed. In the organ I first experimented upon (a pig's liver) the portal system was filled with a blue fluid, composed of recently precipitated Turnbull's blue, suspended in a mixture containing ferrid-cyanide of potassium, acetic acid, alcohol, sugar and water, and the hepatic vessels with carmine and gelatine, but in all the subsequent experiments the blue colouring-matter was suspended in gelatine. The three pigs' livers so treated displayed the lymphatics on their surface in the form of a comparatively speaking large network, the branches of which could without difficulty be distinguished from the blood-vessels by their generally knotted appearance, as well as by their sudden increase and diminution in size. In the pig each superficial lobule is almost, and in many cases, entirely, encircled by a lymphatic vessel or vessels; but in addition to this many branches and loops proceed from the circumference towards the centre of the lobules, the branches diminishing very rapidly in size and terminating to all appearance in very

fine pointed extremities (see Pl. v. fig. 4). How these minute vessels terminate or rather commence in this position it is hardly possible to decide by actual observation, because the dense underlying network of capillaries being filled with injection of the same colour obscure the view; but inferentially we are warranted in concluding that they derive their supply of fluid from the blood-vessels, because in almost every part of the organ which I have examined the commencing lymphatic twigs are occupied with injection of the same tint as the capillaries in close relation to them. Thus, if the capillaries are observed to be violet or red-purple, the lymphatics close at hand will be of a similar colour up to the next valvular swelling, and perhaps beyond it, which circumstance I think clearly proves the continuity of the two sets of vessels. Of course portions of the organs may be singled out where the reverse of this obtains, but such an occurrence is easily explained by the very free anastomoses of the lymphatics, and it in nowise vitiates the correctness of the general conclusion. I have on several occasions seen what I considered to be the actual anastomotic processes of the lymphatics joining the capillaries towards the centre of the lobule in thin sections cut from the surface of the liver; but I would not wish to speak too positively on this matter for reasons which I have before stated. There is no difficulty however in tracing the lymphatics in this part until they become so much reduced in size as to be far less in diameter than the ordinary capillaries of the viscus or even of those supplying the capsule of Glisson (see Pl. VI. fig. 2).

In preparations taken from human livers which I had injected from the portal and hepatic systems with two colours the attenuated radicles of the lymphatics are seen to lose themselves amidst, or (I think I may say after careful and prolonged observation) terminate in the proper capillaries of the organ; and as in the case of the pig the minute lymphatics are almost invariably of the same tint as the capillaries in contact with them, thus shewing from whence they derive their supply of fluids. I have one preparation in my possession which illustrates this in a very striking manner. A lymphatic is observed pursuing a direct course upon the surface of the organ, and is divided into three pretty equal compartments by two valves:

each compartment is filled with injection of a different colour, the first being blue, the second purple, and the third red; whilst the capillaries in the neighbourhood of each compartment are occupied with injection of an exactly corresponding tint[1].

In sections obtained from the surface of the human liver in the immediate vicinity of the hepatic artery (*i.e.* in the fibrous tissue surrounding it) I have ascertained that the smallest lymphatic vessels consist of nucleated fusiform or irregularly stellate cells[2]. In some of my preparations the position of the nucleus is indicated by an oval or roundish light space, the other parts of the cell being filled with injection (see Pl. VI. fig. 1). It may naturally be asked, Are then those fusiform or irregularly stellate cells which have been injected the connective tissue bodies such as have been described by Virchow and others? To this query I think I may safely reply in the affirmative, although it must be confessed that in many instances the processes so injected do not bear a very strong resemblance to these corpuscles when uninjected. But this circumstance I consider to be chiefly due to the cells being

[1] [In a paper, which I read at the meeting of the British Association at Bath in September, 1864, I described (*Med. Times and Gazette,* Sep. 24, 1864), a peculiar relation between the superficial branches of the hepatic artery and the lymphatics. In the pig each branch of this artery is accompanied by two lymphatic trunks which run parallel and in contact with it, and are, as it were, braced together here and there by short transverse branches, which pass both above and below. In this way the artery is more or less ensheathed in lymphatics. In man this arrangement reaches a much higher degree of development, the hepatic artery being in fact enclosed in a fenestrated lymphatic tube. With each expansion of the artery the lymphatics are compressed and their contents propelled towards the heart. Note, 1869.]

[2] The drawings Pl. VI, figs. 3, 4 exhibit very well a phenomenon which I have observed in large numbers of my injections, and which I may be allowed to call attention to here. It is that the so-called nuclei of the capillaries are filled with injection, and stand prominently out from the sides of these vessels when thus distended. From this fact, which I consider very important, it follows that instead of their being oval bodies simply imbedded in the wall of the capillaries, they must (in some instances at least) be regarded as nucleated tubular swellings connecting the blood-vessels with the diaplasmatic system; for I have seen a fine process given off by these nuclei when uninjected which was in every respect similar to the prolongations of the connective corpuscles, and I have satisfied myself by injection that these corpuscles do communicate with the nuclei of the capillaries. Moreover, as it will be seen hereafter that I have succeeded in pushing the injection into one of the fusiform bodies found among the fibrillæ of muscle, and also into the lacunæ and canaliculi of bone, I cannot but consider that the whole of these corpuscles and their prolongations belong to the system which I have named diaplasmatic. It is possible also, I think, that the nuclei of nerve fibres belong to the same category; but of this I have not assured myself by observation.

distended and thus altered in size and form. The expansion of these cells also into lymphatic radicles (which only become visible when thus injected) and the extreme obliquity with which they anastomose with one another and join the larger lymphatic trunks, tend altogether to render observations on single corpuscles in many instances a matter of extreme difficulty. In the fibrous tissue of certain parts however the fine processes which emerge from the capillaries bear a very strong resemblance when injected to fibrous tissue corpuscles. This is well seen in a preparation which I possess[1] of the membrana nicticans of the cat. I have also seen fusiform bodies similar to these in an injected tendon from the same animal and one from the neck of the domestic fowl.

In sections taken from a human thyroid body which I injected from the blood-vessels, the communications of the hæmal and lymph systems can be made out with tolerable facility. In the stroma of this gland the finest lymph-vessels appear to form an exceedingly minute network connected on the one hand with the blood-vessels and on the other merging into the larger lymphatic trunks with which the intervesicular tissue is largely supplied. The general character of the network may be seen in Pl. VI. fig. 7. Sections from the same organ also exhibit another hollow plexus having similar vascular relations. This network however is intra-vesicular and varies in fineness or coarseness according as the cell-elements of the particular vesicle vary in size (see Pl. VI. fig. 7). The network of the thyroid vesicles which I have succeeded in filling with injection correspond in all probability with the trabecular arrangement described by Heidenhain (Moleschott's *Untersuchung*. 1858) as existing in the interior of the glands of a Peyer's patch. I have indeed injected a similar network in the little glandular spots of the frog's intestine, which I think must be regarded as the Peyer's glands of this animal[2]. The capillaries which lie around these spots are enlarged to two or three times their usual diameter, and give off fine processes which

[1] [The Royal Society copy contained a figure of injected fibrous tissue corpuscles in this structure, but the illustration in Pl. VI, fig. 1, is sufficient for the present purpose. (Note, 1869).]

[2] [I have since injected the minute network in a Peyer's patch of the mouse, and through it the central lymph canal of a villus. (Note, 1869).]

unite to form a dense plexus in the meshes of which the cell-elements are placed. I have also noticed an arrangement similar to this in the outer vesicular portion of a lymphatic gland from the abdomen of the cat. In neither of these instances have I as yet been able to discover a lymphatic vessel arising from the networks.

I have now to mention a few more structures in which I have displayed these minute plexuses by means of injection; and although I have not been successful in tracing their connexion with distinctly recognisable lymphatics, I consider them in virtue of their position and minuteness to belong to this system of vessels.

The fin of the perch, which I formerly mentioned as shewing the diaplasmatic network in the interosseous mucous membrane, exhibits also in a very beautiful manner the injection of the lacunæ and canaliculi of the minute bones (see Pl. VI. fig. 4). In this organ the larger blood-vessels run a course parallel with the bones—an artery and a vein for the most part on either side. From these are given off on the one hand the capillaries which supply the web, and on the other large or small branches, which either form loops on the surface of the bones returning to the vessels of the same side from whence they sprung, or, as more frequently happens, anastomosing with those given off from vessels on the opposite side.

In various parts of the bones of the fin small processes filled with injection may be seen connecting the capillaries with the bone corpuscles; and it is quite evident that fluids run freely from one lacuna to another through the intervening canaliculi[1].

[1] [The discovery of the direct communication of the capillaries with the white fibrous tissue corpuscles and other diaplasmatics explains very satisfactorily, I think, a number of pathological phenomena which formerly were inexplicable. How, for example, the increase in the number of blood-vessels takes place in cases of inflammation, and also how after the subsidence of the inflammation the blood-vessels again return to their normal number. We have only to suppose the walls of the diaplasmatics to lose, like the blood-vessels, their ordinary tonicity (and this is what I hold occurs in inflammation), and the blood-globules would at once enter them converting them into blood-vessels. On the recovery of the diaplasmatics from their paralysed state, they would again resume their ordinary functions as bearers of filtered blood or liq. sanguinis. That an actual increase in the number of blood-vessels takes place in inflammation, and not a mere appearance of increase from the enlargement of those already existing, I have convinced myself by injection. I will give but one example of the rapid appearance and disappearance of blood-vessels. We know from absolutely perfect injections, that no blood-vessels can be seen in the human cornea; they

Some of the latter appear to communicate with large irregular cavities situated near the margin of the bone which I think there is every reason to suppose are the lymphatics of the part (see Pl. VI. fig. 4 c). The injection in the irregular cavities is much lighter in colour than it is in the capillaries lying close at hand, and of a finely granular aspect. Such appearances I have also noticed in the lymph-vessels of the thyroid and those of the true skin of the human fœtus and I regard them as characteristic of these vessels when injected through the blood vascular system.

An injected preparation of the scapula of a mouse which I possess also exhibits the lacunæ and canaliculi filled or partially filled with injection from one of the capillary vessels of the periosteum, and this without any observable extravasation[1].

More than two years ago (1862) on examining a portion of injected muscular substance from the diaphragm of the calf, I was greatly surprised to observe that the colouring matter had found its way within the sarcolemma of several fibres, and had extended, from the point of entrance, up and down the fibre almost from end to end. The only way in which such a remarkable phænomenon could be explained, I then thought, was by supposing that rupture of juxtaposed blood-vessel and muscular fibres had taken place, and that the injection had passed

terminate in loops at its margin: but in inflammation of this organ, blood-vessels may be traced over the cornea even with the naked eye, and when the inflammatory action has subsided the blood-vessels may, and often do, entirely disappear. What we call a pathological phenomenon at one period of existence, is in truth but a physiological phenomenon at another: for this enlargement and conversion of diaplasmatics into blood-vessels in inflammation is what occurs naturally in young and growing animals; and it may be seen to perfection in the tail of the newt-tadpole. Here may be observed in the hyaline tissue, cells with numerous off-shoots which anastomose with the branches of neighbouring cells and also with the capillaries close by. The opening-up of the branches communicating with the capillaries may be witnessed in all stages of development if carefully looked for. I may mention too that the nucleus or cell occupying the cavity of the stellate corpuscle bears the strongest resemblance to —is indistinguishable from—the colourless blood-cell. Indeed I regard such cells or nuclei as the parents not only of white blood-cells, but also of pus-corpuscles, and in an abnormal mode of development of cancer-cells also. This view, I am aware, has been put forward by Virchow, and advocated by many pathologists, but when taken in connexion with my discovery by injection of the continuity of the capillaries with the diaplasmatics (white fibrous tissue corpuscles, bone corpuscles and their modifications), and of the capacity of these vessels, under certain conditions, to enlarge and open up, it explains the mode in which cancer germs travel from one part of the system to another, as from the mamma to the axillary glands. Note, 1869.]

[1] [I have also preparations of the spongy bones of the cat's nose which exhibit the injection of the lacunæ and canaliculi. (Note, 1869.)]

from the one into the other. But a further examination of the specimen, and more mature reflection, convinced me that I was not warranted in thus solving the difficulty; for had rupture of both blood-vessel and sarcolemma occurred in close proximity, the injection would have passed more readily between the fibres than have stripped the sarcolemma from the included fibrillæ. Had but one muscular fibre been so affected, this explanation might perhaps have been considered valid, but as several presented the same peculiarity, it was rejected as altogether inadmissible. The conclusion ultimately arrived at was, that a natural communication exists between the interior of the blood-vessels and the interior of the muscular fibres.

The injecting fluid used in this particular instance was of similar composition to that mentioned in p. 101. I have since produced precisely the same results in the muscular fibres of the sheep's tongue with the carmine and gelatine injection. In neither of these instances could I distinctly trace the vessels through which the pigment gained entrance to the interior of the muscular fibres, and some time elapsed before I was able to demonstrate these minute channels by means of injection. At length, however, a frog yielded the coveted preparation; and I can now show satisfactorily the communications in a thin sheet of muscle, composed of but a single layer of fibres, taken from the abdominal wall of this animal, see Pl. VI. fig. 5. In the specimens which I possess exceedingly delicate processes may be perceived coming off from the capillaries, passing through the sarcolemma, and then arranging themselves parallel with the fibrillæ. How or where these channels terminate—whether in the blood-vessels or in the lymphatics—I have not yet ascertained; but I think I have made out that they are in connexion with the nuclei situated among the sarcous elements,—at least I have traced the injection up to one of these nuclei, and have there seen it abruptly terminate. In addition to these fine hollow processes which enter the sarcolemma, there are others which unite to form an irregular network between the different fasciculi. In the frog I have been unable to trace the connexion of this inter-fascicular plexus with lymphatic trunks, but in the muscular substance of the tongue of the sheep and of man I have observed these delicate vessels in communication

with others of much greater size, and which, on account of their irregular form and being filled with injection of a very light pink colour, I think I am warranted in regarding as lymphatic.

Since making these observations my attention has been directed by Dr Turner of Edinburgh to the researches of C. O. Weber (Virchow's *Archiv*, 1859) and of Böttcher, who have described the connective tissue corpuscles lying immediately to the outside of the muscular fibres as anastomosing with each other, and also sending out processes which are continuous with the sarcolemma, or even extend into the muscular fibre, so as to be connected with the nuclei or cells of this structure. From the descriptions of these authors, and more especially from the figure given by Weber of the appearance of the fibrous tissue-corpuscles in suppurating muscle, it appears to me in the highest degree probable that the networks which these observers saw lying to the outside of the fibres, but communicating also with the interior, are identical with those which I have succeeded in filling with injection from the blood-vessels, and through which injection gained access to the interior of the muscular fibres in the cases which I have before mentioned.

While on this part of the subject I may record another very interesting circumstance which I have frequently had occasion to notice, and which would seem to show that the muscular walls of the small arteries are supplied with blood-plasma directly from their interior. In the numerous sections I have made of injected organs and tissues, it has of course sometimes happened that a small blood-vessel has been divided longitudinally, so as to expose the inner lining of the vessel, and a cross section of the circular muscular fibres. In such instances I have occasionally noticed that when the injection-cast was withdrawn the interior of the vessel was transversely striated with the injection, the striation being in bands of about the width of the fibre-cells. This appearance did not at first particularly attract my attention. I thought that it was due to the inner lining being thrown into folds by the longitudinal contraction of the vessel, and that the injection was thus caught and retained in the rugosities; having, however, subsequently observed that the cut edges of the vessel exhibited red spots of injection in the muscular coat and exterior to some of the circular fibres,

I was led to believe either that the injection had penetrated the organic fibres themselves, or that it had penetrated some minute diaplasmatic vessels bearing a close resemblance to them in form and size. The latter supposition would appear to be the more probable of the two; though, from what I have previously mentioned regarding voluntary muscle, it is not by any means impossible that the same phenomenon may happen to involuntary muscle also.

The only portion of the nervous system which has hitherto afforded me an unequivocal example of the plasmatic plexus is the retina, but I have also seen what I am disposed to think are indications of it in the brain of a human fœtus of the 5th month, and in the ganglionic portion of the spinal cord of a cat. The retina which exhibited the network (see Pl. VI. fig. 3) was obtained from the last-named animal, and it is only in spots, here and there confined principally to the fundus, that it is capable of being distinguished. Concerning its relation to the cellular elements of the organ I am able to give no information, in consequence of the membrane having been dried on glass before I was aware of the existence of the network. Its minuteness and delicacy when injected are, however, so very great that it is questionable whether it could be seen at all in the natural semi-opaque condition of the organ.

I have now mentioned all the more important facts which have been elicited during my investigations, and which bear directly upon the distal communication of the blood-vascular with the lymphatic system, or which illustrate how widely distributed are the plasma-conveying channels in the vertebrate organism. My researches would seem indeed to justify the conclusion that such channels are common to all organs and tissues with the exception of articular cartilage, in which I confess I have not yet been able to detect anything approaching to a reticular arrangement[1].

[[1] Shortly after writing the above I made a number of special observations on the structure of cartilage, and I discovered in sections taken from one of the bones of the human wrist, and stained with carmine, clear evidence of reticulation. This reticulation I suppose to represent the channel system of cartilage, though I have no further proof of it to offer than that the reticulations pass from the margins of the cartilage lacunæ, and that I have here and there observed granules, apparently fatty, lying in the direction of the lines of the network, and as I believe in the plasma canals. See Pl. VI. fig. 6. I may here state that I

To some it may appear strange that previous investigators of the vascular system have never succeeded in distending these plexuses with the mineral colouring matters which are usually employed. This circumstance, however, will not appear at all surprising when we take into consideration the extreme minuteness of the diaplasmatic channels, and the difficulty ordinarily experienced in making a perfect, or even tolerably perfect, injection of the capillaries with such materials. Who, for example, has ever seen a brain or retina perfectly injected with vermilion or chromate of lead? Yet with the carmine fluid both of these organs may be injected with comparative ease and certainty. Looking, indeed, at the tendency shown by the finest mineral pigments to attach themselves to the parietes of the vessels, and finally choke them up, and furthermore considering the extreme minuteness of these diaplasmatics, I do not think it possible that they will ever be demonstrated, in the higher animals at least, by means of such injections.

With regard to the offices performed by these fine tubular networks, I have for the present but little to say, except that I consider all those found in the epidermal or mucous tissues to be especially and peculiarly connected with the function of secretion, and probably also but in a minor degree with that of absorption; while those situated in the deeper parts of the organism, such as muscle, fibrous tissue, &c. are employed in conveying blood-plasma to, and effete matters from, the tissues through which they run or with which they may be in contact[1].

Plate V.

Fig. 1. Portion of mucous membrane of Frog's palate as seen with $\frac{1}{4}$-inch objective:—*aa'*. Capillaries. *bb*. Blood-corpuscles. *c*. granular nucleated pervious network. *c'*. Ditto injected. *d*. Deep and *d'*. superficial view of nucleated cells of mucous membrane.

now entertain the opinion that every living cell or fibre of the higher organisms is in direct connexion at some part of its surface with a channel conveying nutritive fluid. (Note, 1869.)]

[1] I must here acknowledge my obligations to my friend Prof. Turner for many valuable suggestions which he has made, and also for his care in superintending the execution of the plates which illustrate this paper.

Fig. 2. Fold of mucous membrane of Frog's bladder:—*a*. Superficial layer of cells of mucous membrane. *b*. Granular nucleated pervious network. *c*. Deep layer of cells. *d*. Capillary.

Fig. 3. Injected lung of Toad ($\frac{1}{2}$-inch objective):—*a*. Capillaries. *b*. Plasma vessels (diaplasmatics) injected. *c*. Nuclei of cells of air vesicles.

Fig. 4. Lobule of Pig's liver (inch objective):—*a*. Outline of lobule. *b*. Large lymphatic trunks. *cc'*. Capillaries. *ddd*. Primary radicles of lymphatics.

Plate VI.

Fig. 1. *a*. Lymphatic vessel of human liver lying above hepatic artery ($\frac{1}{6}$-inch objective). *b*. Fibrous tissue corpuscles filled with injection and connected with lymphatics.

Fig. 2. *a*. Lymphatic of Pig's liver, commencing in—*b*. Minute branching cell. *c*. Blood capillaries of capsule ($\frac{1}{6}$-inch objective).

Fig. 3. Retina of Cat (dried on glass and mounted in balsam) ($\frac{1}{4}$-inch objective):—*a*. Capillaries. *bbb*. Minute network (diaplasmatic). *cc*. Nuclei (?) of capillaries filled with injection.

Fig. 4. Pectoral fin of Perch 5 inches long ($\frac{1}{4}$-inch objective):—*aa*. Blood-vessels. *bb*. Capillaries. *c*. Minute network (diaplasmatic) in mucous membrane covering the bone. *d*. Bone corpuscles filled with injection from capillaries. *e*. Lymphatic vessel (?). *f*. Articulation of bones. *g*. Pigment cells.

Fig. 5. Muscular fibre of Frog ($\frac{1}{2}$-inch objective) showing capillaries and fine injected processes passing from them into the interior of the fibre.

Fig. 6. Cartilage from bone of human wrist stained with carmine, and showing delicate reticulations (plasma channels?) with granules here and there ($\frac{1}{4}$-inch objective).

Fig. 7. Section of portion of injected human thyroid ($\frac{1}{2}$-inch objective):—*a*. Artery. *b*. Capillaries. *cc*. Large lymphatic trunk surrounding artery. *d*. Plasmatic network in thyroid vesicle communicating with capillaries and lymphatic.

ABSTRACT OF A REPORT ON THE SPECTROSCOPIC EXAMINATION OF CERTAIN ANIMAL SUBSTANCES, PRESENTED TO THE BRITISH ASSOCIATION AT EXETER 1869, by E. RAY LANKESTER, B.A. OXON.

THE principal objects which I had in view in making the observations which form the subject of the report, were to examine more carefully the green blood component which I had discovered in the Annelids Siphonostoma and Sabella and to which I gave the name Chlorocruorin (*Journal of Anatomy*, Nov. 1867) and also to look further into the nature of the Chlorophyl-body which I had found by means of the spectroscope in Spongilla and in Hydra. I was also anxious to ascertain the distribution of Hæmoglobin in the animal kingdom.

Value of absorption-spectra[1] *as evidence as to identity or distinctness of bodies.* Some persons who have not worked at absorption-spectra have questioned the value of these phenomena as a means of research. It appears, however, from a now very large series of examinations that it may be fully admitted, 1st. That no two bodies giving *identical* absorption-spectra are themselves distinct, and conversely no two bodies giving distinct absorption-spectra are identical in their chemical and physical constitution; the strength of this evidence being increased in proportion to the number of bands in the spectra compared. 2nd. Two bodies may present spectra very nearly identical, so as at first to deceive the eye, and yet have but the remotest connection in chemical constitution.

Instrument and method. All spectroscopes are not equally well adapted to the study of *banded absorption*-spectra, those used for studying *flame*-spectra or the *solar*-spectrum not being well suited to this purpose. A special combination of prisms is required, and that devised by Messrs Sorby and Browning is the best I have seen, though being of small size and intended

[1] The term 'absorption-spectra' is used to designate the phenomena presented by many liquids, solids, and gases, differing essentially from the absorption-lines of incandescent vapours with their corresponding luminous spectra.

for use with the microscope, the Sorby-Browning spectroscope might be easily improved. It is particularly desirable that the observer should be able to examine one portion of the spectrum without the eye being dazzled by the light from another part; and this is not provided for in so small an instrument. Perhaps the most essential and necessary part of a spectroscope for studying absorption-spectra is a means of introducing two spectra to the eye, one over the other for comparison. This is fully provided for in Mr Sorby's eyepiece; but its absence is a fatal objection to Mr Crooke's recent device. It is necessary to compare absorption bands side by side as to intensity, sharpness and position: a mere fixing of position on any scale is not sufficient.

A *scale* is however very useful for recording the position of bands. The solar lines offer a graduation of the spectrum, which nevertheless it is not convenient to use. A millimetre scale has been used by some observers; but such a scale must be special to each spectroscope, and not readily appreciated by those who merely read of it. No band could be even approximately identified from a description that it was at 125 on a millimetre scale, in which the chief solar lines had such and such positions. Mr Sorby has proposed Nicol's prisms and a quartz plate of such thickness as to give twelve bands in the spectrum, which he numbers, the solar line D being at 3½. This would be very much more useful, if one could get the quartz plate rightly prepared. It is so difficult to do this and to keep it in order that some less troublesome standard is needed. The numerous bands in the spectrum of light passed through the orange-brown gas $N_2 O_4$ have long been known; and I have carefully mapped nearly 40 of these and had them printed so as to form a scheme for the registration of spectra[1], adding one line in the extreme red, viz. of the solution of chlorophyl in HCl. The $N_2 O_4$ gas is easily prepared and kept in a small glass tube and *can not get out of order*. A band referred to one of its bands must be recognisable in any spectroscope by those who can get a small quantity of the gas.

Should any screen sufficiently sensitive be ever available,

[1] I shall be happy to send one of these maps to any person working at absorption-spectra. E. R. L.

photography would at once supplant all other means of registering and comparing absorption-spectra. The whole solar spectrum has been photographed by Becquerel; so we may have hope. As matters at present stand a most important means of examining absorption-bands in the blue end of the spectrum which are often exceedingly obscure to the eye—will be found, I believe, in the use of photography.

Illumination is of very great importance in the study of absorption-spectra. Solar beams are not always to be had. A light stronger and whiter than an ordinary gas lamp, but equally convenient in use, is wanted. A recently patented platinum lamp promises to supply this desideratum.

Three *different thicknesses* of a solution should be always studied and compared, or one of Dr Gladstone's wedges used.

Colouring matters which do not furnish separate absorption-bands. The following list of cases I have examined may prevent others from searching in vain, and at the same time afford data for determining the meaning of absorption-bands.

Tegumentary pigments generally, with the remarkable exception of the red soluble colour of the wing feathers of the Turacus discovered by Prof. Church, give no bands, e.g. *Hair-colours of Mammals: feathers of birds*, of which were examined, Pyranga œstrox (scarlet), Scarlet Ibis, Harvest Pheasant (orange), Scarlet Macaw, Cock of the Rock (orange), Trogon puella (crimson), Indian Rolla (blue), Hæmatoderus militaris (crimson and brown), Meadow Lark of Jalapa (crimson), Hyphantes Baltimoriensis (yellow), Pitta maxima (scarlet and blue), Red crowned chatterer, Juida leucogaster (black-grey), Rupicola viridis (green), Richardson's Barbet (crimson), Paradisia regia (brown). *The pigments of the scales of Fish*, e.g. Gar-fish or Belodon (green scales and green bones), Mackerel, Red Mullet, Wrasse, &c. *Pigments of Molluscan shells*, e.g. Janthina (purple), Pecten (red), also pigments of compound Tunicata and of Polyzoa (orange, crimson and green). *Tegumentary pigments of Insects*, e.g. of various caterpillars, coloured transparent wings of Alpine Locusts, scales of Lepidoptera. *Red orange and blue pigment of Crustacea*, e.g. of Alpheus ruber, eggs of Maia squinado, red and blue pigment of Cheirocephalus, red pigment of small Entomostraca. *Red pigment of Echino-*

dermata, e.g. of Comatula. *Pigments of Annelids*, green of Trocheta and of Phyllodice. *Pigments of marine sponges. Yellow pigment of intestine of some Annelids. The Tyrian purple from Purpura. The Red exudation of the Hippopotamus.*

Distribution of Hæmoglobin in the Animal Kingdom.—The Crustacean Phyllopod, *Cheirocephalus diaphanus*, is added in my Report to the list of Invertebrata formerly noticed in this Journal (Nov. 1867) as possessing Hæmoglobin in their blood. This is the only crustacean in which Hæmoglobin has as yet been found. In some other insect larvæ allied to Chironomus I have also found Hæmoglobin. There are thus among all Invertebrata but very few—for mollusca only *Planorbis*, for crustacea only *Cheirocephalus*, for insects only *Chironomus*, and several genera among Annelids, which are known to possess Hæmoglobin in their blood: by far the majority of Invertebrata have none. The Lamelli-branchiate genus Arca is stated to have red-coloured corpuscles in the blood; this and the red vascular fluid of some nemertean worms ought to be examined with the spectroscope. The muscular tissue of mammals and birds contains Hæmoglobin, as first shown by Kühne. It is remarkable that it is absent from the muscles of most reptiles and fish. The *most active* muscles in some fish appear to contain it, just as the most active vertebrates are provided with it in their muscles throughout.

Professor Pflüger of Bonn regards the Hæmoglobin in blood not as the essential or direct means of taking up oxygen, but as providing a store to be called upon when wanted. Thus its absence in most Invertebrata and its presence in a few is rendered somewhat less remarkable.

The following fluids gave either a blue coloration or an effervescence when treated with guaiacum and peroxide of hydrogen. Hæmoglobin and chlorocruorin give a blue coloration to guaiacum by simple exposure without the addition of peroxide of hydrogen: as also 'plant-juice,' for instance that of Leontodon, is stated to do, by Schnetzler (*Archives des Sciences*, Sept. 1869). My friend Dr Arthur Gamgee suggested to me the desirability of making these experiments.

1. Vertebrate, blood—strong effervescence and blueing.
2. Planorbis blood (red)—strong effervescence and blueing.

3. Chironomus larva—strong effervescence and blueing.
4. Green-blood of Sabella—strong effervescence & blueing.
5. Red-blood of Earthworm—strong effer. and blueing.
6. Colourless perivisceral fluid of the Earthworm—feeble effervescence and blueing.
7. Ditto of Sabella—feeble effervescence and blueing.
8. Colourless blood of Julus (myriapod)—medium effervescence and blueing.
9. Ditto of a large Beetle—(feebler than 8) and blueing.
10. Ditto of a Caterpillar—(feebler than 8) and blueing.
11. Ditto of an Hemipterous Insect—(feebler than 8) and blueing.
12. Ditto of Lymnæus stagnalis—very slight effervescence, no blueing.
13. Ditto of Helix aspersa—medium effer. and blueing.
14. Ditto of Blatta orientalis—slight effer. no blueing.
15. Ditto of Gammarus—slight effer. and blueing.
16. Ditto of Astacus fluviatilis—slight effer. and faint blueing.
17. Small Entomostraca—slight effervescence, no blueing.
18. Masses of Vorticellidan—effervescence, no blueing.
19. Hæmatin (alkaline solution)—strong effer. and blueing.
20. Cruentin (alkaline)—strong effervescence and blueing.
21. Reduced and oxy-Hæmaglobin equally } strong effervescence and blueing.

White of eggs, mucus, saliva, &c. are all quite negative as to this test.

The action of some re-agents on Hæmoglobin as observed with the Spectroscope.—In order to examine Chlorocruorin satisfactorily, I have repeated many of the re-actions of Hæmoglobin with various bodies and given drawings in the Report in which the position is fixed by the N_2O_4 map, and the intensities of the bands as they appear to the eye (in some cases in three different thicknesses of solution) are rendered. The spectra of Oxyhæmoglobin, reduced Hæmoglobin, CO-hæmoglobin, NO-hæmoglobin, Sulphæmoglobin, alkaline Hæmatin, acid Hæmatin, Stokes' reduced Hæmatin, Cyanhæmatin and Cyanosulphæm, are those given. CO-hæmoglobin was first made known by Hoppe

Seyler; its absorption-spectrum differs clearly from that of Oxyhæmoglobin in the fact that the band nearest red is in CO-Hb, a very little more to the blue end and relatively fainter than in O-Hb (see fig. A and B). I mention this more particularly because I have found that cyanogen gas produces the same spectrum in blood-clot solution as does carbonic oxide and probably its toxic action is the same (fig. B). This spectrum produced by agitation with cyanogen gas in excess, is not changed by the addition of reducing solutions—thus further resembling that produced by carbonic oxide. We may infer the existence of a compound Cy-Hb, similar to the Co-Hb, NO-Hb, HCy-Hb, MNO_2-Hb already known to physiologists. This view of the action of cyanogen gas on blood is opposed to that of Laschkewitsch (Reichert u. Reymond's *Archiv*, 1868, p. 649), chronicled in Dr Gamgee's report in this Journal, IV. May 1869. Laschkewitsch states that cyanogen gas reduces a solution of Hæmoglobin. He is probably led to this conclusion by the observation of the Cyanhæmatin of Hoppe Seyler (having missed altogether the spectrum seen by me) which has a single broad band in its spectrum resembling but *quite distinct* from that of reduced Hæmoglobin (see fig. C and D). Cyanhæmatin, I found, was formed from the solution of Cyanhæmoglobin, after it had stood some two hours or more, the pinkish red-colour being changed to an orange-brown. Doubtless the cyanogen forms hydrocyanic acid or a cyanide.

Cyanhæmatin has been described both by Hoppe Seyler and Preyer (see Dr Gamgee's reports in this Journal). It may be formed either from Hæmoglobin or Hæmatin by gently heating with cyanide of potassium, and gives the band drawn in fig. D. On adding sulphide of ammonium to this Preyer observed two bands resembling those of Stokes' reduced Hæmatin. They are not, however, when first formed identical with, but gradually become indistinguishable from, those of that body. The intermediate spectrum in which the bands differ from those of Stokes' reduced Hæmatin, in being of nearly equal intensity, may be known as Cyanosulphæm. Stokes' reduced Hæmatin (fig. E) is a very uncertain and changeable body, which requires much further investigation. Sulphæmaglobin is the name proposed in my report for the band noticed by Nawrocki, as produced on

the addition of sulphide of ammonium (or of any alkaline sulphide according to Preyer) to blood-clot solution. The band of reduced Hæmoglobin is then found to be accompanied by one in the red, which may be obtained with great distinctness, by corking up for three days a strong blood-solution with a twentieth of its volume of the sulphide. This is the band of Sulphæmaglobin. I have carefully fixed its position, and find it to be quite distinct from that of any other Hæmoglobin-derivative (see fig. C). It is convenient to have a name for it. By further action, blood thus treated, gives the spectrum more or less clearly of Stokes' reduced Hæmatin.

In observing the spectra of the product of the action of nitrites on the blood—discovered by Dr Arthur Gamgee—I found on the addition of sulphide of ammonium to the nitrite-blood to which a little ammonia had been previously added—as he directs—that the darker band of Stokes' reduced Hæmatin became visible in the midst of the broad band of reduced hæmoglobin, which he records as being formed. Also on the addition of the ammonia to the nitrite-blood, a clouding occurred in the position of the alkaline Hæmatin band. The band, in the extreme red of the nitrite-blood, agrees exactly with that of acid Hæmatin, as Dr Gamgee observes. It therefore seems not improbable that, on addition of ammonia, a small quantity of Hæmatin is really formed, which was partially developed on the first addition of the nitrite to the blood, as indicated by the band in red—but which does not separate—clinging like the nitrite itself in definite quantity to the crystals of the blood thus treated. This is not inconsistent with the fact demonstrated by Dr Gamgee—that nitrites form a molecular combination with Hæmoglobin.

Chlorocruorin. From twenty specimens of the not uncommon annelid *Sabella ventilabrum* a sufficient quantity of the green blood fluid was obtained for experiment; but I must beg the reader to bear in mind, that the quantity was minute, and could only be studied by means of Mr Sorby's instrument. The normal spectrum of this liquid gave two bands, one as figured in this *Journal*, Nov. 1867, the other fainter and nearer the blue. The spectrum is very distinct from any other, fig. F. On addition of reducing agents (sulphide of ammonium or sulphate

of iron with tartaric acid and ammonia) the two bands were changed to one—having nearly the same position as the darker of the two—but fainter, fig. G. On agitation with the air, the two bands return. Hence we may infer an oxidised and reduced condition. A variety of experiments failed to yield any derivatives of chlorocruorin—recognisable by bands—apparently on account of the instability of the body which decomposes rapidly. But the treatment with cyanide of potassium and sulphide of ammonium, which in the case of hæmoglobin yielded to Preyer the two bands above spoken of—*yielded in the case of Chlorocruorin identical bands.* On addition of KCy and gentle heating, the bands of Chlorocruorin entirely disappear: when $NH_4)_2$ S is added to this, a dark band at once appears similar in position to, but darker on the blue side, than the chief band of chlorocruorin. As this is watched with the spectroscope it is seen to fade, and gradually two bands make their appearance equal to each other in intensity, identical with those of Cyanosulphæm, fig. H. The dark band produced at first entirely disappears, and the solution which was green becomes red. These bands do not ever pass, as far as I could ascertain, into exactly the conditions of intensity and position of Stokes' reduced Hæmatin, but fade away entirely from the solution in the course of a day.

Thus a very interesting fact is established, namely, that these two bodies, Hæmoglobin and Chlorocruorin, ***have a common base*** in this Cyanosulphæm[1], and perhaps in Stokes' reduced Hæmatin.

Whether Chlorocruorin has the same position relatively to this base as Hæmoglobin, or whether it stands only on the lower level of Hæmatin or less degraded derivatives, remains for further enquiry.

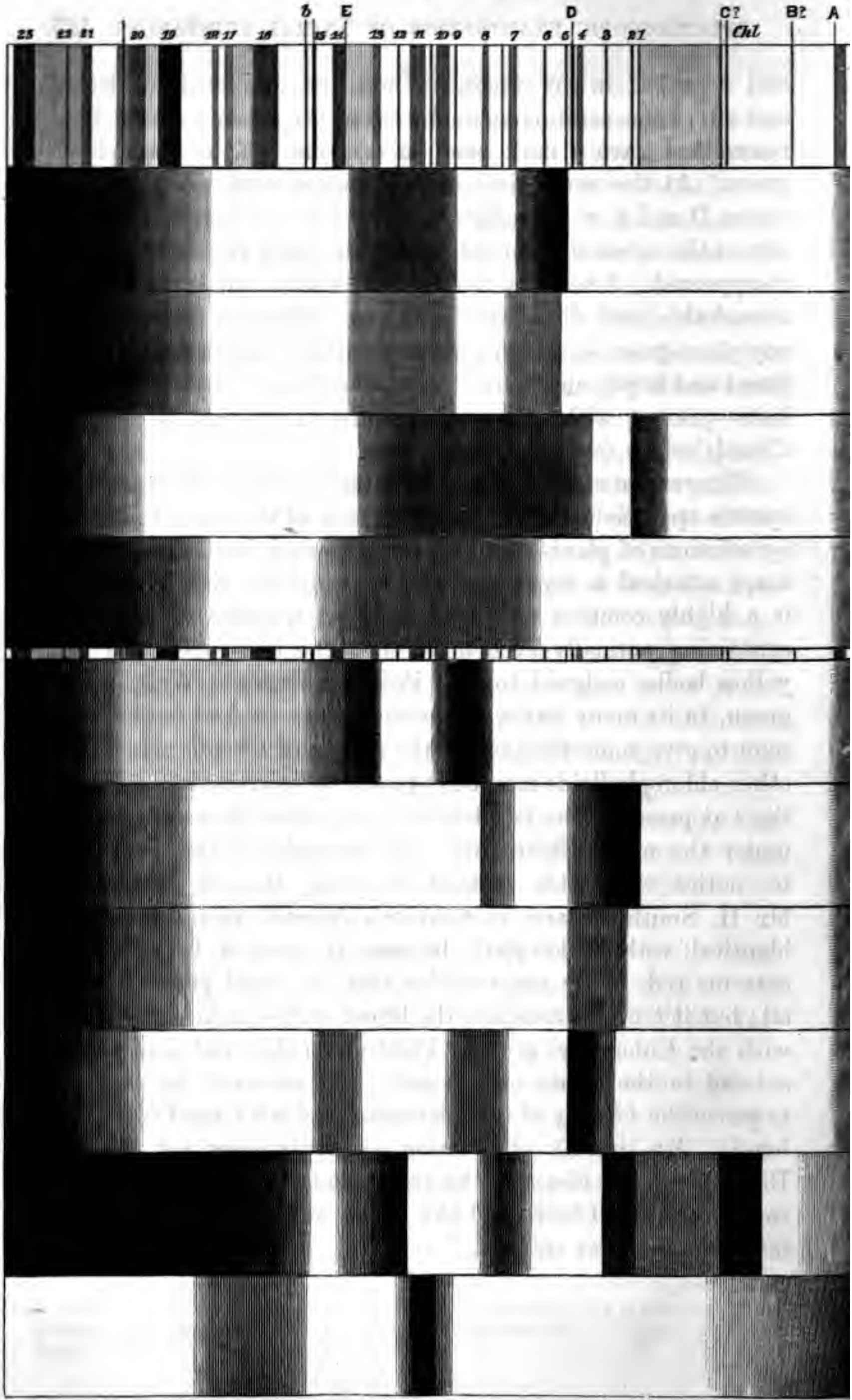
I could not succeed in obtaining any satisfactory reactions with Chlorocruorin and carbonic oxide or cyanogen, but I have indications spectroscopically of an action similar to that (Nawrocki's) of the alkaline sulphides on Hæmoglobin.

Chondriochlor. Spectra obtained by careful extraction of the chlorophylloid matter of *Spongilla fluviatilis* are mapped

[1] I do not wish to attribute the importance to this term of a chemical compound. It is the name for a particular spectrum caused by an undetermined body.

and described in my report. When first extracted by alcohol and after concentration again by ether, the green solution fluoresced and gave a dark band in extreme red, as does plant-green. At the same time a band commenced to appear between D and E of the solar spectrum, which increased in intensity as the solution was kept, whilst the band in red ultimately disappeared. After nine months the solution presented a most remarkable and distinctive spectrum, differing entirely from any plant-green spectrum known (solutions being similarly prepared and kept), and hence I infer that there is a distinct body here—present with others no doubt—which may be termed Chondriochlor (see fig. J).

Figures are necessary to render these and the above-noticed spectra appreciable to the reader. Some of the spectra afforded by solutions of plant-green, variously treated, are drawn in the maps attached to my report; and it is inferred that chlorophyl is a highly complex and protean body, splitting up into and containing normally even more than the two green and two yellow bodies assigned to it by Professor Stokes. When plant-green, in its many forms, has been further studied (and I hope soon to give some time to it), the nature of Chondriochlor and other chlorophylloids may be expected to receive some explanation: at present there is a tendency to confuse them all together under the name Chlorophyl. An example of this has come to notice while this abstract is going through the press. Mr H. Smith declares in *Silliman's Journal*, that Diatomin is identical with Chlorophyl, because it gives *a* band in the extreme red. I do not consider that the band proves this at all; but it tends to associate the brown endo-chrome of Diatoms with the Chlorophyl group. Plant-green does not give simply a band in the extreme red; and great care will be required to prove the *identity* of the Diatomin band with any Chlorophyl band. Mr Smith's observation assuredly does not tie the Diatomaceæ any closer to the vegetable kingdom, as he appears to think, since Chlorophyl-like green substance is known in many of the lower animals.



b
E
D
C?
B?
A
Chl
25 23 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

EXPLANATION OF THE WOOD-CUT.

At the top is drawn a portion of the spectrum as graduated by the lines and bands furnished by N_2O_4 gas, the solar lines A, B, C, D, E, *b*, F, being also introduced. The line between 7 and 8 and that between 10 and 11 are so faint as to be imperceptible with the Sorby eye-piece, except under very favourable circumstances—a larger spectroscope, made by Mr Browning, was used for this observation. The bands drawn in this figure are more numerous than in any other figure of the spectrum of this gas which I have seen : compare for instance that in Prof. Roscoe's recent volume on Spectrum-analysis. The series of lines is repeated again between D and E for convenience of reference. The figures are very much larger than the spectra appear to the eye with the microspectroscope : they are also drawn of less than half the relative vertical extent which it is usual and convenient to make them occupy during observation. In this way the differences between juxta-posed spectra have been made more obvious than they have appeared in the spectroscope. It is necessary to make these qualifying remarks for the sake of those who may repeat the observations with a similar instrument.

The intensity of solution selected in the figures is that considered as shewing best the bands. Elsewhere I shall give various intensities, stating accurately the strengths and thicknesses of solution when possible.

A. A solution of blood-clot of medium strength and thickness, shewing the two bands of Oxy-hæmoglobin.

B. A portion of the same solution agitated with Cyanogen gas : shewing the spectrum of Cy-Hb identical with that of CO-Hb. The band on the right is perhaps a little too pale.

C. A somewhat stronger solution of blood-clot, gently warmed with $NH_4)_2S$, and kept closed for some days: shewing on the left the broad band of simple or reduced Hæmoglobin, and on the right the characteristic band of Sulphæmoglobin. The broad Hb band becomes but little *narrower* in more dilute solutions, diminishing chiefly in *intensity*.

D. Blood-clot solution of same strength as C, gently heated with KCy, giving the spectrum of Cyanhæmatin. The difference between the band of this body and the superposed broad band of reduced Hæmoglobin is sufficiently clear. Also obtained by keeping solution B (Cy-Hb) for a few hours.

E. Stokes' reduced Hæmatin.

F. Green blood of *Sabella ventilabrum*, shewing the two bands of Oxy-chlorocruorin.

G. The same, after addition of the reducing iron-solution.

H. Green blood of Sabella, heated gently with KCy, and $NH_4)_2S$ added in small quantity. On the right the temporary dark band which appears on addition of $NH_4)_2S$ is seen. This band appears without previous addition of KCy when excess of the sulphide is used. On the left the two bands of Cyanosulphæm are seen, making their appearance at first faintly.

I. A solution of the green matter of Acacia-leaves in alcohol, taken up by Ether after evaporation; kept for nine months, protected from light.

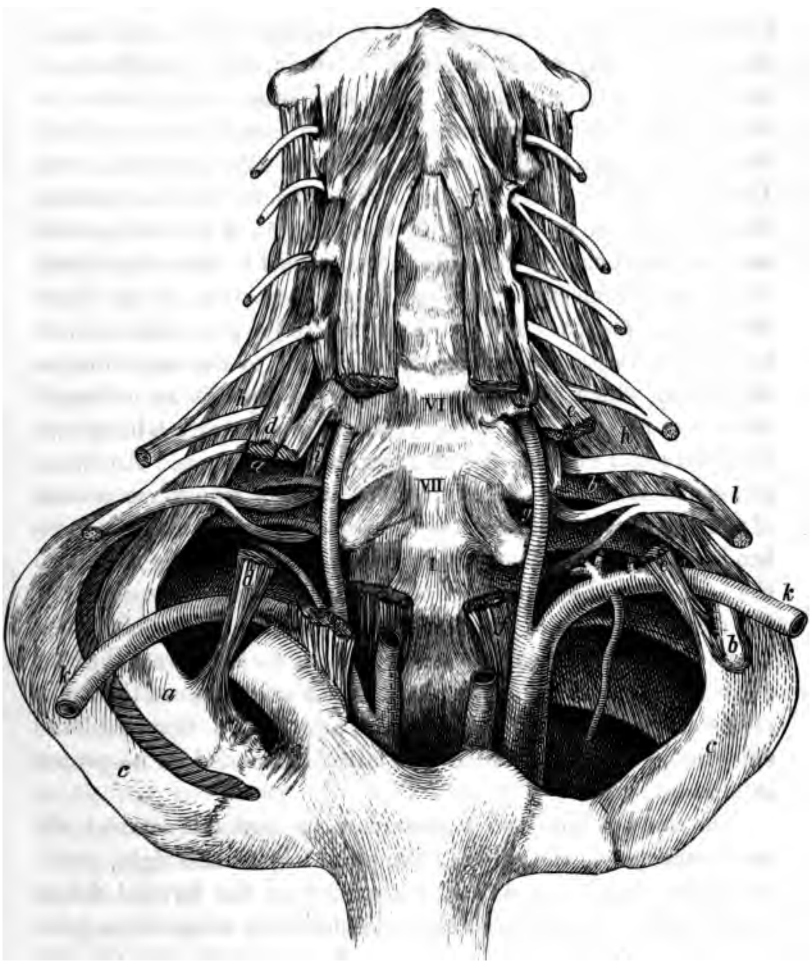
J. A similarly prepared and similarly preserved solution of the green matter of *Spongilla fluviatilis*, shewing the bands distinguished as Chondriochlor.

ON SUPERNUMERARY CERVICAL RIBS.

By PROFESSOR TURNER.

CASES in which supernumerary cervical ribs are found in man are not so frequent, but that a description of several specimens which I have examined may be of interest. A large proportion of the cases which have been recorded, embraces little more than a description of the bones, with some reference perhaps to the position of the subclavian artery. In one of my cases, however, I fortunately detected the nature of the variation at an early stage of the dissection, and was enabled to examine the modifications in arrangement which were presented by the adjacent soft parts.

Case 1. An adult female dissected in my practical rooms April, 1869. Vertebral formula C. 7, D. 12, L. 5, S. 5, Coc. 4. On the *right* side a well-formed moveable rib was situated at the root of the neck, immediately above the 1st thoracic rib, with which it closely corresponded in shape. Its head articulated with a slight tubercle-like elevation on the upper part of the side of the body of the 7th cervical vertebra, to which it was connected by a stellate ligament; whilst its tubercle articulated with the strong transverse process of the same vertebra, which had the general form of the transverse process of a thoracic vertebra. This rib arched forward across the side of the neck, so that its anterior extremity blended with the cartilage of the first thoracic rib and through it was connected to the manubrium sterni. The supernumerary rib where it joined the costal cartilage was hard and nodulated, and its texture resembled that of ossified costal cartilage. The costo-clavicular ligament was attached partly to it and partly to the cartilage of the 1st thoracic rib. A well-marked intercostal space, gradually diminishing in size from behind forwards, and occupied by a pair of intercostal muscles, separated the supernumerary from the 1st thoracic rib. The *scalenus anticus* was attached to a tubercle at the inner border of the cervical rib, close to its sternal end. The *scalenus medius* was attached, not only to its neck, but for



Explanation of figure:—VI. VII. Sixth and seventh cervical vertebræ. I. First dorsal vertebra. *a.a.* Right cervical rib. *b.b.* Left cervical rib. *c.c.* First pair of thoracic ribs. *d.d.* Right. *e.e.* Left scalenus anticus. These muscles are represented with pieces cut out to show the neck of the supernumerary and 1st thoracic ribs, and the 7th and 8th cervical and 1st dorsal nerves. *f.f.* Longus colli, divided to show the heads of the supernumerary and 1st thoracic ribs with their stellate ligaments. *g.* Vertebral artery. *h.h.* Right and left middle scalene muscles. *i.* Inter-transverse muscle. *k.k.* Right and left subclavian arteries. *l.* Lower cord of brachial plexus. From a careful drawing of the specimen by my pupil, Mr Millen Coughtrey.

some distance along the upper surface of the shaft. Between the attachments of these muscles the rib was grooved for the lodgment of the subclavian artery, which vessel was consequently not only considerably elevated in, but brought much closer to the anterior surface of the neck. Immediately in front of the tendon of the scalenus anticus, the surface of the cervical rib was smooth and rounded for the passage of the subclavian vein. The roots of the brachial plexus lay between the two scalene muscles, and the cord formed by the junction of the 8th cervical and 1st dorsal curved upwards and outwards in front of the neck of the supernumerary rib to aid in the formation of the lower cord of the plexus. The 1st dorsal nerve gave its usual branch to its own intercostal space, and a branch to the supernumerary space, which latter was continued outwards as a lateral cutaneous nerve. The 8th cervical nerve also gave a branch to the intercostal muscles of the supernumerary space. An *intertransverse muscle* extended from the anterior transverse process of the 6th cervical vertebra to the supernumerary rib close to its head. The vertebral artery ascended in front of this muscle to the foramen at the root of the 6th cervical transverse process, and the 7th cervical nerve passed outwards behind it; the conjoined deep cervical and superior intercostal arteries arose from the root of the vertebral; the former passed backwards between the necks of the cervical and 1st thoracic ribs, and gave a branch to the supernumerary space, whilst the latter descended to its proper intercostal space.

On the *left* side the supernumerary moveable cervical rib was connected to the spine in the same way as the right, but it was more slender, and did not extend so far forward, for its anterior somewhat pointed end articulated by a moveable joint with a feeble tubercle on the upper surface of the 1st thoracic rib close to its inner border, 1·2 inch behind the costal cartilage. Both the cervical and thoracic ribs were encrusted with cartilage at this joint, and a thin interarticular disc of fibrocartilage was interposed. A capsular ligament and synovial membrane were also present. The *scalenus anticus* was attached partly to the anterior end of the supernumerary, and partly to the adjacent inner border of the 1st thoracic rib, and the subclavian artery rested in a groove on the cervical rib

just behind the muscle. Neither the muscle nor the artery were thrown so far forward as on the right side. The subclavian vein was situated altogether on the 1st thoracic rib in front of the muscle. The *scalenus medius* was partly inserted into the supernumerary and partly into the 1st thoracic rib. The inter-transverse muscle was more slender than on the right side. The supernumerary intercostal space was shorter and narrower than the right, and the fibres of the scalenus medius filled up the interval. The relations of the vertebral and deep cervical arteries and of the nerves of the brachial plexus were much the same on the two sides.

The heads of the 1st pair of thoracic ribs articulated not only with the 1st thoracic vertebra, but with the lower part of the side of the body of the 7th cervical vertebra. The 12th thoracic vertebra and its ribs were peculiar. On the *left* side the vertebra had three distinct processes in the region of the transverse process; a mammillary, an accessory, and a stunted costal process, which projected outwards, and was in series with the lumbar transverse processes. On the anterior surface of the costal process was a smooth, oval, articular facet, covered with cartilage, which articulated by a capsular ligament and synovial membrane with a corresponding surface on the posterior aspect of the last rib. This rib, 8 inches long and 4 at its widest part, was a flat piece of bone, without any subdivision into head, neck, or tubercle, but tapering at its inner end, which was connected to the outer surface of the pedicle of the 12th thoracic vertebra by a strong ligament, but without cartilage or synovial membrane. The articular facet on its posterior aspect was close to the inner end of the rib.

On the *right* side there was no moveable twelfth thoracic rib; and the vertebra possessed not only mammillary and accessory processes, but a strong elongated costal transverse process, pointed at its free end, which projected ·6 inch outwards beyond the base of the mammillary process. It closely resembled in shape and size the lumbar transverse processes, with which it was in linear series. The texture of the bone was paler at the free end of this process than at its root, and a slight tubercle and ridge marked the line where these different appearances blended with each other. The right transverse pro-

cess of the first lumbar vertebra had a similar aspect. The fifth lumbar vertebra was ossified to the base of the sacrum, both by its body and thick wing-like transverse processes.

In the Anatomical Museum of the University of Edinburgh are several dried specimens, which illustrate the chief modifications that may be exhibited by supernumerary cervical ribs. With two exceptions these specimens have not, so far as I can ascertain, been described. A brief statement therefore of their characters may prove an interesting supplement to the recent dissection which I have just related.

Case 2. 383 c. Dried specimen of 6th and 7th cervical and 1st dorsal vertebræ. Adult male. A pair of cervical ribs, each of which had a distinct head, neck and tubercle, articulated with tubercle-like elevations on the side of the body of the 7th cervical and with its enlarged transverse processes. The right rib was stunted and measured only 1·5 inch from its head to its anterior free-pointed end. The left, nearly three inches long, was grooved on its upper surface for the subclavian artery, and resembled the rib of the same size in Case 1. 1st pair of thoracic ribs articulated by their heads to the bodies of the 7th cervical and 1st dorsal vertebræ—vertebral arteries entered foramina at roots of 6th cervical transverse processes. No other soft parts present. This specimen was described and figured by Dr Archibald Dymock in the *Edinburgh Medical and Surgical Journal*, XL. 1833.

Case 3. 383 d. Dried specimen of 6th and 7th cervical, 1st and 2nd dorsal vertebræ. Adult. On right side a moveable cervical rib articulating in the usual way with body and transverse process of 7th vertebra. It was 2·2 inches long, had a pointed anterior end, and a faint subclavian groove. On the left side there was no moveable rib, but the transverse process consisted in the normal manner of its two subdivisions with the intermediate foramen. The free extremity of the posterior transverse process was thick and prominent. 1st pair of thoracic ribs articulated only with 1st dorsal vertebra.

Case 4. 383 e. An adult 7th cervical vertebra. On the left side the anterior transverse process is developed into a moveable rib. The head and neck are both slender, and the body of the rib is stunted and projects only ·6 inch beyond the

tubercle. In addition to the articulation of the rib by its head to the tubercle-like elevation on the side of the body, and by its tubercle to the transverse process, the posterior border of the slender neck had an irregular articular facet for the anterior surface of the transverse process; corresponding arrangements had obviously existed on the right side, but unfortunately the rib had been lost.

I believe that 383, c. d. and e. had at one time formed a part of the anatomical museum of the late Dr Robert Knox, and it is probable that they are the specimens to which he refers, though without describing them, in the *London Medical Gazette*, Vol. II. 1843, p. 530.

Case 5. 383 f. The 7th cervical and upper dorsal vertebræ of a child, age unknown. Two very short rudimentary ribs are connected to the 7th cervical vertebra. They appear to be anchylosed by their tubercles to the vertebral transverse processes, but the slender neck of each at its head articulates with a very distinct tubercle-like elevation on the side of the body of the vertebra. On the left side a slender bar of bone lies behind and parallel to the neck of the rib, subdivides the interval between it and the transverse process into two foramina, and is continuous at its extremities with the body and transverse process of the vertebra. Each rudimentary rib projects only ·3 inch beyond the vertebral transverse process. The 1st pair of thoracic ribs articulate only with the first dorsal vertebra.

Case 6. 387. The first pair of thoracic ribs. A strong process ·6 inch in breadth at its base and ·4 high rises from the upper surface of the shaft of the right rib close to its inner border and ·8 in front of the tubercle. This process is broad and flattened on its summit, and has obviously been intended for the attachment of the anterior end of such a cervical rib as exists in the specimen in the Anatomical Museum of the University of Cambridge, figured by Mr Quain in his great work on the *Arteries*, Pl. 25, Fig. 9, and by Prof. Humphry in his *Treatise on the Human Skeleton*, Pl. VI. Fig. 1; or in the specimen which Prof. v. Luschka has figured (Pl. 1, Fig. 3) in the *Denk. der Kaiserl. Akad. der Wissenschaften*. Wien, 1859. 387 forms a part of a skeleton obtained from an ancient long stone cist near Yarrow Kirk, Selkirkshire, the anatomy of which

I examined along with my friend Dr J. Alexander Smith some years ago[1].

Case 7. A few years ago, when accompanying my friend Mr Paget in the visit to his wards at St Bartholomew's Hospital, he directed my attention to a young woman, on the right side of whose neck a pulsating body, obviously an artery, could be distinctly felt to the outer side of the sterno-mastoid muscle, close beneath the skin and some distance above the clavicle. The artery was supported by a bone the end of which was readily felt beneath the skin. Mr Paget had diagnosed the case as one in which the subclavian artery had been displaced upwards by a cervical rib on which it rested. In a letter with which he has recently favoured me Mr Paget states that he has seen three other cases of a similar character.

From these cases and from two others which have been recorded, as observed during life, by Dr Willshire[2] and Dr Wolters[3], it is evident that in the living person cervical ribs may attract the notice of the practitioner. The finger placed at the side of the root of the neck may detect, more especially if the cervical rib ends free anteriorly, or articulates with such a strong tuber on the thoracic rib as Case 6 possessed, a projecting piece of bone, which might be mistaken for an exostosis; in the one case from the cervical spine, or in the other from the 1st thoracic rib. But a much more important distinguishing character is the existence of an easily felt pulsating structure above the line of the clavicle, and at no great distance from the surface of the neck. A hasty examination of such a case might lead to a suspicion of aneurismal disease. And as it is important that an error of this kind should be avoided, I append some remarks which Mr Paget, who has enjoyed unusual opportunities of examining these cases during life, has favoured me with in the letter above referred to. "In each case the imitation of aneurism was close enough to deceive an unwary surgeon; but to one who examines closely and has in his mind what the case may be, the mistake seems scarcely possible, so long as the artery is healthy. I can well believe, however, that great difficulty of diagnosis

[1] *Proc. Soc. Antiquaries of Scotland*, 1864—65, p. 65.
[2] *Lancet*, 1860, Vol. 2, 29 Dec., p. 633.
[3] Related by Huntemüller of Göttingen in *Henle u. Pfeufer's Zeitschrift*, 1867, p. 155.

would exist in any case in which the unusual arrangement of parts is combined with a morbid state of the artery, especially with that state in which arteries, not evidently diseased in texture, have more than natural pulsation. This state is common in the abdominal aorta, and I have seen it two or three times in subclavian arteries and in carotids."

Displacement and easily felt pulsation of the subclavian artery do not however always accompany a cervical rib. If the rib be short and consist of little more than head, neck and tubercle, as in Case 5, then the artery arches in the usual manner over the first thoracic rib. If the cervical rib arches well forward to the side of the sternum, accompanied by a forward displacement of the scalenus anticus, as on the right side of my Case 1 (see the figure), then the artery also passing forwards is not so much raised above the level of the clavicle as might at first sight be supposed. The greatest elevation of the artery in the neck seems to be associated with that form of cervical rib in which the latter does not bound much more than the posterior half of its own side of the thoracic inlet, as in the left side of Case 1.

It is scarcely necessary that I should enter into a discussion of the general question of the morphology of these cervical ribs, as most anatomists admit that they are homologous with the ribs in the thoracic region, and with the short ribs found in the necks of the crocodiles and some other reptiles. The condition of the transverse processes of the last dorsal vertebra in Case 1, may serve to illustrate the morphology of the three tubercles into which it is usually divided. For not only were there mammillary and accessory processes, but the external, or costal process, more especially on the right side, had grown outwards in form like to, and in series with, the transverse processes of the lumbar vertebræ.

Some months after the dissection of the first case which I have related in this paper I received, through the courtesy of Professor Wenzel Gruber of St Petersburgh, his very elaborate essay on cervical ribs, which had just been published in the memoirs of the Imperial Academy of that city[1]. In this

[1] Tome XIII. No. 2, St Pétersbourg, 1869. Professor Gruber enjoys unusual opportunities of studying the variations which occur in human structure. In a

essay he gives an account of 5 cases[1] which he had himself dissected, and reviews and criticizes the cases which other anatomists have recorded. His survey of the literature of this subject has been so complete that it will be of interest to give a short analysis of the leading conclusions he has come to. Commencing with the observations of Hunauld, made 129 years ago[2], 76 examples of cervical ribs in man, occurring in 45 individuals, have been recorded. To these should now be added the specimens for the first time described in this communication. They have been seen in both sexes and at all ages, even in an embryo of six months (Rosenmüller). Usually they occurred on both sides of the 7th vertebra, but more than one pair has not been met with in the same person. Sometimes they were anchylosed to the body and transverse process (or only to the latter) of the 7th vertebra—only seldom did they end anteriorly in a distinct costal cartilage. Usually only an external intercostal muscle occurred in the supernumerary space. My first case it will be remembered presented a pair of these muscles on the right side. Cervical ribs may be either the unusually developed rudiments of the anterior transverse process, or rib, of the 7th vertebra: or merely unusually developed epiphyses, articulating only with the transverse process of the 7th vertebra, as in the specimens described by Moret[3] and Foucher[4]. In the former case, which is the more frequent, they are homologous with the inferior roots of the transverse processes in birds and the cervical ribs in crocodiles; in the latter with the rudimentary ribs connected with the 8th and 9th cervical vertebræ in *Bradypus tridactylus*, and with a rudimentary rib once seen by Gruber in *Canis familiaris*. When a rudimentary rib is a developed anterior transverse process, it may present one or other of four degrees of development: (*a*) where it is very short and possesses only a head, neck and tubercle: (*b*) where it extends beyond the transverse process, possesses a body, and

printed report of the work done in the Anatomical School, he states that in 6 years 4167 dead bodies, 378 of which were newborn children and embryos, had been supplied for the use of the Professors and Students, and for examinations, preparations, and the practice of operative surgery.

[1] Two of these had previously been published by him. *Neue Anomalien*, Berlin, 1849, and *Virchow's Archiv*, 1865.

[2] *Mém. de l'Acad. roy. des Sciences*, ann. 1740. Paris, 1742.

[3] *Bull. de la Soc. Anat. de Paris*, 1836. *Bull.* 7, No. 2, p. 10.

[4] *The same*, 1856. Vol. I. p. 69, No. 2, and p. 25, No. 17.

ends either free, or joins the 1st thoracic rib: (*c*) where it reaches beyond the transverse process and is connected either by ligament, or the anterior end of its body with the 1st costal cartilage: (*d*) where it resembles a true rib, possesses a costal cartilage, which joins, with the cartilage of the 1st thoracic rib, the manubrium sterni. As a rule the head of the cervical rib articulates with a cylindriform process or elevation on the side of the body of the 7th vertebra. In my description I have applied the name of tubercle-like elevation to this process. Cervical ribs terminate anteriorly, either free, or become connected with the 1st thoracic rib or with the sternum. The connection with the thoracic rib is mostly with its osseous part, either by anchylosis, or by a fibrous union, which is either purely ligamentous or is a joint with a capsular ligament. The connection with the sternum is by cartilage. Not unfrequently a process, eminence or tuber, exists on the thoracic rib at the place where it articulates with the cervical rib. Prof. Gruber considers that the rule laid down by Halbertsma[1] and supported by Luschka[2], that a cervical rib 5·6 cent. and more in length supports the subclavian artery, whilst one shorter than 5·1 cent. does not support it, is untenable, as specimens have been seen by Srb and himself in which this rule was not borne out; besides, the age of the person examined necessarily affects the length of the ribs. He considers that the deep groove found on the upper surface of a cervical rib, when it supports the subclavian artery, is not merely due to the pressure of that artery, but also to the lower roots of the brachial plexus.

[1] *Arch. f. d. Holland. Beiträge.* Utrecht, 1858.
[2] *Denk. der Kaiserl. Akad. der Wissenschaften.* Wien, 1859.

OBSERVATIONS UPON THE MOVEMENTS OF THE CHEST. By ARTHUR RANSOME, M.D. Cantab.

THE instrument with which the following observations were made, was constructed to measure simultaneously, in three dimensions, the movements of any point on the chest during one or more acts of respiration.

It consists of a light steel rod having at one end a small button attached to it by a ball-and-socket joint; the other end of the rod is connected with some simple machinery which records the motions of the rod, giving duly the movements of the button-end forwards, upwards and outwards.

The diagrams will suffice to show the nature of the mechanism.

The lever (L) is connected, by means of a swivel-joint at Q, fig. 2, with a transverse shaft, N, N′, which is hung upon pivots, pp′, at each end; it is therefore capable of rotating, to a certain extent, in two planes at right angles to one another, horizontally and vertically. It also moves in a third plane, at right angles to the other two, backwards and forwards; the pivots, pp′, are connected by means of pillars, with a stage (A, C, D, E), which moves easily upon the two slides, (S, L). Each of these movements is recorded upon a separate dial, by means of an index, and two loose registering fingers: thus the forward motion is communicated to its index (f) by a stationary rack (R, fig. 2), and a pinion (F) attached to the moveable stage; the upward motion is given by the lateral rackwork upon the segment of a wheel (W, figs. 1 and 2) attached to the shaft (N, N′). This rackwork moves a small pinion (u) also fixed to the stage (A, C, D, E), and this in its rotation turns the index (u′). The outward motion is transmitted to the index (o) by the rackwork (K) and pinion (O), and in order to allow of free movement to the lever up and down, this rack is worked in vertical lines upon the surface of the segment of a sphere.

The movements are each registered separately upon three dials, but the indications of the forward motion need a slight correction owing to the influence upon it of the radial movements of the lever. The amount of error however is very small. In the instrument used for these observations it was less than 2 per cent. of the extent of upward or outward motion. It is intended in any future instrument to lengthen the lever and to multiply the radial movements. When this is done, the error from this source will be inappreciable.

When the instrument was used, it was placed in a box and fixed by a split-ring and screw to an upright pillar at any required height; and this pillar was clamped to any convenient table. Great care was taken in applying the instrument, to fix the spine of the patient by means of a straight-backed chair, the tips of his fingers resting on the table, and if possible, the head was also allowed to rest against a support. In this manner the probability of any side-movement or bending of the spine, not due to respiration, was reduced to a minimum.

The button-end of the rod was then brought against certain points of the chest supported by the bony framework; and, owing to the shortness of the lever, these points have hitherto been selected from the anterior wall of the chest.

If it was desired to take the extreme extent of several respirations, the patient was allowed to go on breathing forcibly several times before the instrument was stopped; and if the extent of ordinary breathing only was required, the patient was permitted to take several quiet respirations before the registering fingers were placed in position.

It is necessary to state that several sources of fallacy in applying the instrument have been regarded, and that corresponding precautions have been taken. Thus, in any instance in which the breathing has been unnatural or irregular from nervousness, officiousness or anxiety, the observations have been rejected as worthless. If it has appeared also that the patient's body has moved, apart from the thoracic movements, the registering-fingers have been set afresh, and one or more successive readings have been taken.

It is scarcely needful to remark that obesity is a complete bar to the use of the apparatus. If there was much fat upon the ribs it was found impossible to keep the button of the lever pressed evenly upon them. This circumstance however was of the less consequence, since most of the patients who required these observations to be made were already reduced in flesh by disease; and for physiological purposes subjects were selected who were spare or even thin.

The following table gives the results of some of the measurements made upon healthy persons at different ages.

TABLE I.

Showing in healthy persons at different ages, the extent and direction of the movement of different points of the chest in 100ths of an inch.

	Extent and direction of movement of	Top of Sternum.	Centre of Sternum.	Ensiform Cartilage.	Centre of Clavicle (Right).	Centre of Clavicle (Left).	3rd Rib (Right).	3rd Rib (Left).	5th Rib, near nipple (Right).	5th Rib (Left).	Remarks.
1	Forwards						98				Male, Æt. 6.
	Upwards						96				Healthy, thin, tall.
	Outwards						21				
2	Forwards				30	29					Female, Æt. 6.
	Upwards				36	36					Healthy, small.
	Outwards				9?	12?					
3	Forwards	98	98		64	64					Male, Æt. 9.
	Upwards	111	96		117	120					Healthy, thin, tall.
	Outwards										
4	Forwards	51			51	51	61	59			Female, Æt. 27.
	Upwards	45			51	60	60	63			Healthy (stays on).
	Outwards										
5	Forwards	117			85	102					Female, Æt. 27.
	Upwards	114			99	99					Healthy (wearing stays).
	Outwards										
6	Forwards	56	44		56	61					Female, Æt. 33.
	Upwards	81	84		63	75					Thin, delicate; no other
	Outwards										physical signs.
7	Forwards		98		56	59			112	102	Male, Æt. 28.
	Upwards		111		99	90			180	180	Healthy, strong.
	Outwards								36	30	
8	Forwards	90	96	80	90	78	80	85	102	102	Male, Æt. 35.
	Upwards	111	120	99	108	105	129	135	135	120	Healthy.
	Outwards						27	27	30	30	
9	Forwards	85	85		59	59					Male, Æt. 42.
	Upwards	135	150		135	135					Healthy, large chest.
	Outwards										
10	Forwards	127			85	82					Male, Æt. 33.
	Upwards	84			90	99					Healthy, strong.
	Outwards										

The observations now given are not brought forward as complete in themselves. The instrument is still susceptible of much improvement, and the number of measurements has been too small to justify the deduction of fixed conclusions from

them. The few notes which have been made may however show the direction towards which these experiments tend.

From carefully observing the action of the stethometer in these and similar measurements the following notes have been made:

1. In ordinary breathing, in adults, the extent of movement of the ribs is extremely small, and is very irregular in extent, even in the same person, especially if the attire is the ordinary one. Both in men and women the dress is an impediment to breathing with the ribs. In children the degree of movement is greater relatively than in adults.

2. At different ages the degree and kind of movement varies greatly, and there seems to be no fixed proportion between the extent of movement in different directions—as a general rule however the upward movement exceeded the forward; and in the situations measured, both these motions exceeded the outward motion.

3. In individuals of the same age, without any real difference in the capacity of the chest there is often a very different extent of movement of the chest wall. Sometimes the motion indicated by the instrument is less when the capacity of the chest is greater. These measurements in fact simply express the different degrees of elasticity of the chest and the varying mobility of its parts.

4. In forcible breathing, the index F (giving the forward movement) is most equable in its motion throughout the whole act of respiration, but it is generally most rapid towards the close of the inspiration, when the extraordinary muscles of breathing are brought into play.

5. In women and children the upward movement starts at the same time, and keeps pace with the forward motion.

6. In men the upward movement takes place chiefly at the latter portion of the respiratory act, when the sterno-mastoid muscles and external intercostals are brought into action.

The outward movement on those parts of the chest which I have been able to reach with the present short lever is very small, so small that I regard many of the indications as doubtful, and I have so marked them in the tables; when the movement is multiplied and the lever lengthened, I hope to obtain more satisfactory results. Even now however it is to be

observed on some of the upper ribs, that the maximum of the outward movement of their centres lies within the extreme limits of the act of breathing, as if the rib sometimes rose above the horizontal level.

7. In some persons the act of sighing does not consist so much in a general expansion of the chest as in the simple raising of the whole thorax. In these cases the sigh caused a considerable deviation of the index (U) with very little corresponding movement of index (F).

8. Again, in some full-chested men I have noticed that the earliest periods of the expansive act are accomplished by the lower ribs, which seem to swing from above, and then the final act of breathing consists of the expansion forwards of the upper ribs, and the raising of the whole bony cage.

It is very interesting to notice the great extent of the upward movement in many persons, young and adults, and also to remark that the amount of movement, to some extent, coincides with the comparative muscular strength of the subjects. In most cases the movements on the right side are the greatest. There seems to be good reason to hope that the method may eventually throw some light upon the action, in different circumstances, of the different muscles, ordinary and extraordinary, of respiration.

By measuring the various degrees of movement of the chest wall in different positions of the hands and arms, it appears that the most favourable posture for forcible breathing, is when the body is firmly fixed, and the hands grasp the edge of a table, or a bar at the ordinary height of a table.

When the hands are raised above the head, or when they are allowed to rest with the tips of the fingers on the breast, the movements are decidedly diminished, the upward motion being most affected; and when the hands are clasped behind the head, they are lessened in some persons to the extent of 25 to 50 per cent.

The following Table gives a few measurements made upon patients suffering from phthisis, emphysema and chronic bronchitis.

TABLE II.

Showing in different diseases the extent and direction of the movement of different points of the chest in 100ths of an inch.

Fig: 1

SECTIONAL END ELEVATION.

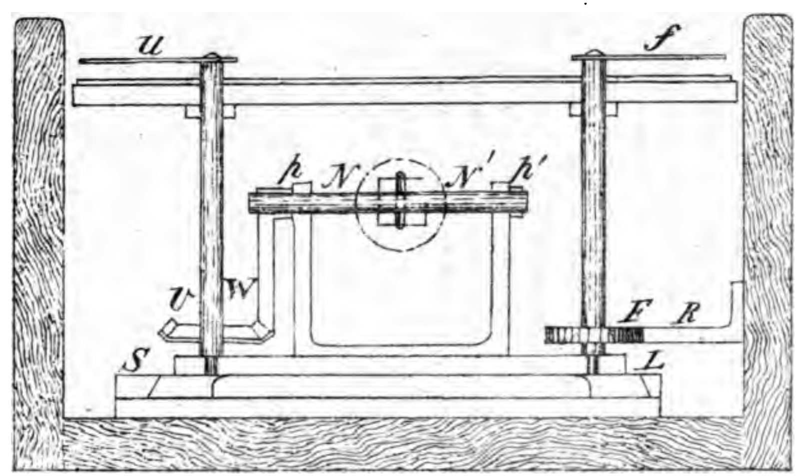
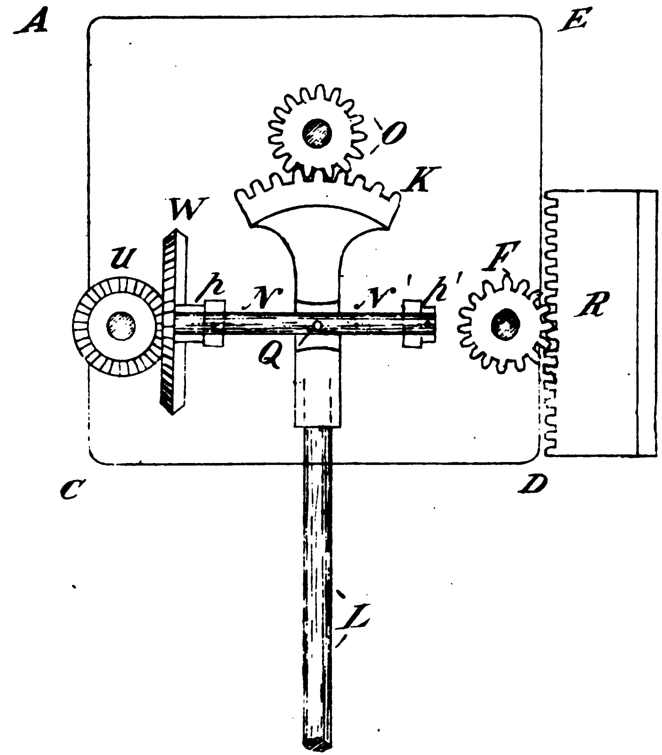


Fig: 2.

SECTIONAL PLAN.



PIWLSON & SONS MANCHESTER.

Fig: 3.

SECTIONAL SIDE ELEVATION.

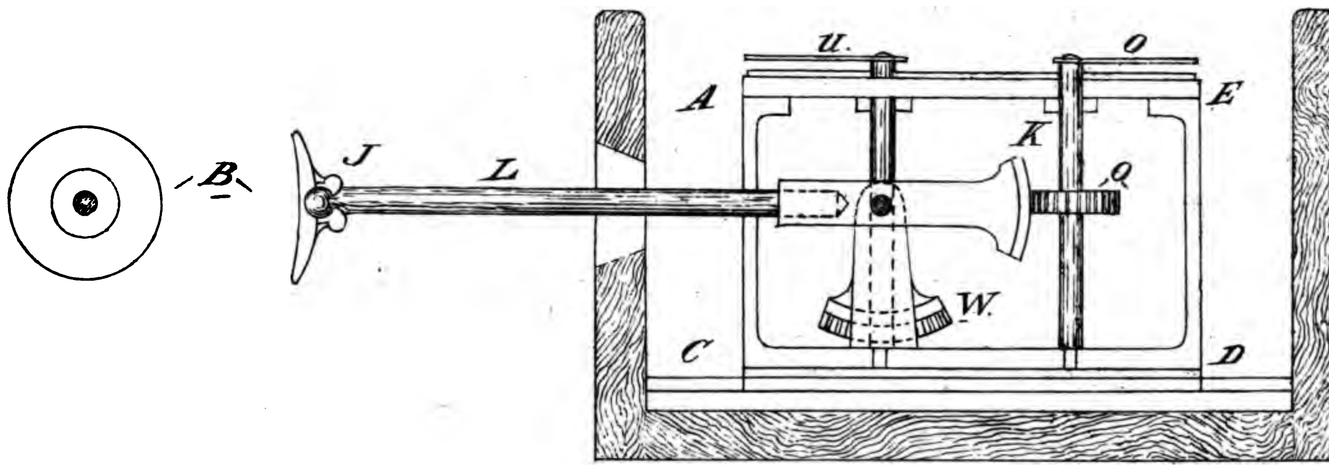
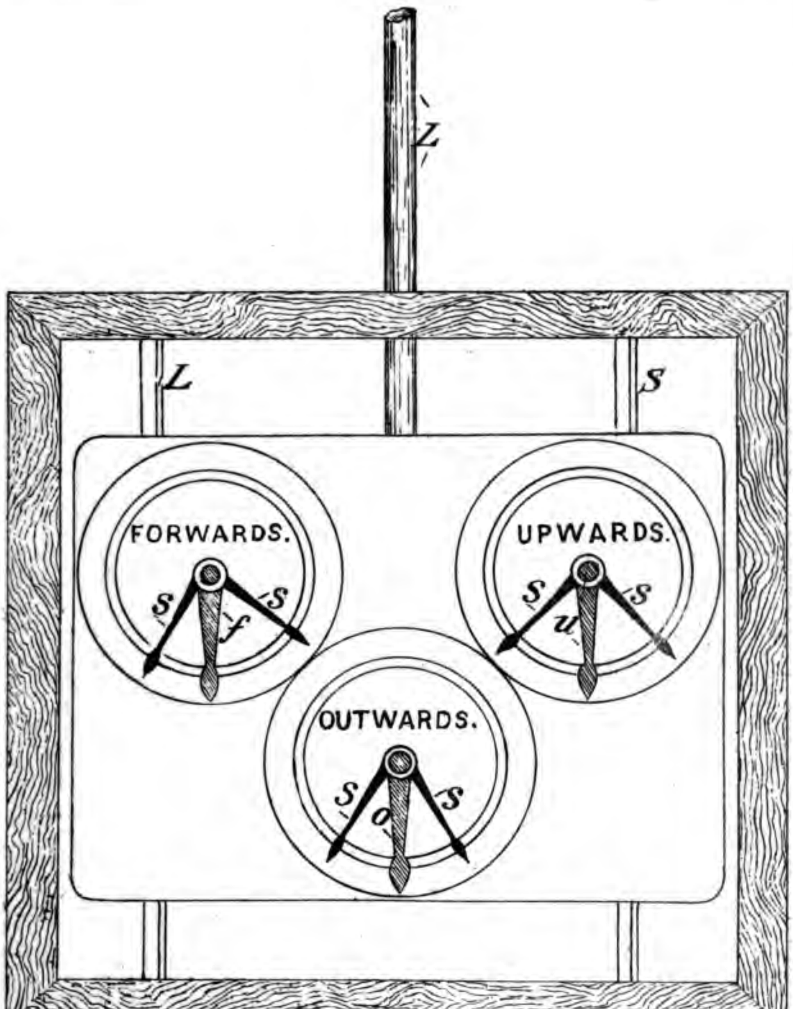


Fig: 4. PLAN.



	Extent and direction of movement of	Top of Sternum.	Middle of Sternum.	Ensiform Cartilage.	Centre of Clavicle (Right).	Centre of Clavicle (Left).	3rd Rib (Right).	3rd Rib (Left).	5th Rib (Right).	5th Rib (Left).	Remarks.
11	Forwards						59	34			Female, Æt. 27. Phthisis, both lungs. *Right* side, 1st stage, 3 in. below clavicle. *Left*, vomica, dry, long-standing. Contraction of ribs.
	Upwards						75	51			
	Outwards						27(?)	27(?)			
12	Forwards	51			48	39	67	42			Male, Æt. 50. Phthisis, both lungs. *Right*, large, uncontracted vomica, dry. *Left*, recent tubercular deposit, 3 in. below clav.
	Upwards	45			45	51	66	51			
	Outwards	—					30	27			
13	Forwards	49			47	39	68	56			Female, Æt. 19. Phthisis, 2nd stage. *Right* side healthy. *Left*, 4 or 5 in. below clavicle, softening tubercle.
	Upwards	57			75	36	63	45			
	Outwards						36	21			
14	Forwards	34			17	24	42	42			Female, Æt. 52. *Phthisis*, 1st stage. *Right* side tubercle 1—2 in. under clavicle. *Left*, healthy, slight bronchitis.
	Upwards	60			60	27	60	51			
	Outwards										
15	Forwards	92					85	80			Male, Æt. 27. *Phthisis*, formerly Pleurisy, copious hæmoptysis. *Right* side healthy. *Left*, incipient tubercular deposit.
	Upwards	90					105	90			
	Outwards						36	24			
16	Forwards	28		27			42	34			Male, Æt. 50. *Emphysema*, incipient phthisis on *left* side.
	Upwards	51		51			60	45			
	Outwards						27(?)	24(?)			
17	Forwards	42			34	54	90	85			Male, Æt. 60. Chronic Bronchitis. *Right* side incipient phthisis. *Left*, healthy except bronchitis.
	Upwards	69			69	57	69	105			
	Outwards										
18	Forwards				39	34	42	41			Male, Æt. 50. Chronic Bronchitis, Emphysema on both sides.
	Upwards				57	36	57	54			
	Outwards										
19	Forwards	56			46	39	59	59			Female, Æt. 47. Chronic Bronchitis, incipient tubercle on both sides 1½ in. below clavicles, contraction on Left side, softening on *Right*.
	Upwards	39			45	45	48	36			
	Outwards										
20	Forwards		42		41	34	76	65	70	61	Male, Æt. 30. Softening tubercle through left lung.
	Upwards		69		54	42	81	60	75	66	
	Outwards								39	36	
21	Forwards	39	42	56	19	37	42	68			Female. *Right* side, extensive tubercular deposit, vomica under 3rd rib, sinking under clavicle. *Left* side, slight tubercular deposit.
	Upwards	60	60	60	45	54	60	81			

In Phthisis the indications of diminished motion in each direction are generally very marked on the affected side, but the forward motion is generally more affected than the upward and outward, and thus the relative proportion of these movements is sometimes considerably altered.

The total mobility of the chest-wall may even be less impaired in the second stage than the first stage of phthisis. I have recorded in the Table a case of this disease (no. 12), in which there was an uncontracted vomica on the right side and incipient tubercular deposit on the other, and the movement of the right side was 67 forwards and 66 upwards, and on the left 42 forwards and 51 upwards.

In Emphysema the general movement of the chest-walls is very much diminished, especially if the case is complicated with asthma, as it frequently is; this fact has been observed by many. Thus Dr Hyde Salter (*On Asthma*, 2nd ed. p. 169) remarks, "there is no movement or pliancy in the body, but the chest is fixed and rigid, like a box, and from it the arms depend, &c."

The case no. 16 noted in the Appendix was a good example of this disease, but it is interesting to observe that the movements of the chest are not equally diminished, the upward motion is much less affected than the forward, so that in some positions the former greatly exceeded the latter. The whole thorax seemed to move together, raised upwards 'en masse,' without much movement of the ribs relatively to one another. It is perhaps owing to this circumstance that the fixation of the arms gives such assistance in Dyspnœa. The pectoral muscles not only act upon the ribs to which they are attached, but help to move upwards the whole of the thoracic walls.

NOTE OF A CASE OF DISPLACEMENT OF THE SUB-MAXILLARY GLANDS. BY PROFESSOR TURNER.

SOME months ago, whilst assisting two of my pupils to dissect the parts below the inferior maxilla, it was seen that no submaxillary glands were present in the digastric triangles, and that the facial arteries therefore were not surrounded by gland substance. On the right side three, and on the left two, lymphatic glands were the only glandular structures met with in these triangles.

When the mylo-hyoid muscle on each side was reflected, a considerable mass of lobulated gland substance was exposed which in part occupied the position of the sublingual gland, and appeared at first sight to be an unusually large example of that structure.

When more carefully examined, however, it was seen that, without dividing gland substance, but by merely cutting through connective tissue, the mass could be subdivided into two portions, each of which was about equal in size to the normal sublingual gland. The gustatory nerve lay in the connective tissue which separated the two portions of gland substance.

The higher of these two portions was in the normal position of the sublingual, whilst the lower rested on the genio-hyoglossus close to the genio-hyoid. From this lower portion, which I regard as the displaced submaxillary gland, a duct proceeded, which ran forwards and opened into the floor of the mouth, close to the frænum linguæ. It was obviously the duct of Wharton, though smaller in size than is customary, for the gland substance from which it proceeded was very considerably less than the normal submaxillary.

On the right side a branch of the lingual artery supplied both the sublingual and the displaced submaxillary, whilst on the left side both portions of gland substance were supplied by a branch of the facial artery.

NOTICES OF NEW BOOKS.

Handbuch der Lehre von den Geweben des Menschen und der Thiere. Herausgegeben von S. Stricker. Leipzig, 1869.

The second part of this very excellent work on Microscopic Anatomy has just appeared. It contains articles on the minute structure of the heart by Schweigger Seidel: of the blood-vessels by Eberth; of the lymphatics by Von Recklinghausen: of the spleen by W. Müller: of the thymus by E. Klein: of the thyroid by E. Verson: of the blood by A. Rollett: of the salivary glands by Pflüger: of the teeth by F. Waldeyer; and the first part of an article on the alimentary canal by E. Klein and E. Verson.

Practical Anatomy: a manual of dissections by Christopher Heath. 2nd ed. London, 1869.

We may announce the publication of a second edition of this useful dissecting-room manual. The text has been carefully revised and several new woodcuts have been introduced.

Mind and Brain: or the correlations of consciousness and organization. By Thos. Laycock, M.D., Professor of the Practice of Medicine in the University of Edinburgh. 2 Vols. 2nd edition. London, 1869.

A second edition of this well-known treatise has just appeared. The principles and method followed by the author, and applied by him to philosophy, mental science and practice, arise out of that "fundamental fact of experience, that every state of consciousness coincides with molecular changes in the encephalon, without which no change in the consciousness can arise, and which, being vital, are independent of consciousness." He has in this edition worked out, more completely than in the former, the law of evolution, and has applied it not merely to psychological and biological facts, but has endeavoured to show that it may be applied to the correlations of the molecular forces, "the *vis nervosa* and vital energy are the result of the evolution, conservation and accumulation of chemical energy."

Untersuchungen zur normalen und pathologischen Anatomie der Froschhaut, von DR CARL JOS. EBERTH, Professor der pathologischen Anatomie in Zürich. Leipzig, Verlag von W. Engelmann, 1869, 4to. pp. 32.—This pamphlet commences with a description of the

minute anatomy of the skin of the Frog, carefully worked out by the author with a view to the elucidation of pathological processes, and is illustrated by plates. The two morbid conditions investigated are cancroid growths and cyst-formations. Both take place in the deeper stratum of the cuticle: the former consisting in preternatural growth of the cells which sprout into the cutis and envelope the glands and other structures. The cysts he has found only in the Rana Esculenta and during the spring; and he associates their formation with the greater fulness and softness of the skin at this breeding period, which depends not simply upon the presence of more fluid but also upon the free growth of the elements both of the cutis and cuticle.

Der Bau des menschlichen Corpers von Dr CHR. AEBY, Professor der Anatomie in Bern. Verlag von F. Vogel, Leipzig.—The second part of this work on Anatomy has just reached us. It treats of the muscular, alimentary, respiratory, urinary and genital systems, and in the same good style as the asseous system was treated of in the first part, of which a brief notice was given in this Journal, Vol. III. p. 188.

REPORT ON THE PROGRESS OF ANATOMY.
By PROFESSOR TURNER[1].

OSTEOLOGY.—Observations by G. W. Callender ON THE FORMATION AND EARLY GROWTH OF THE BONES OF THE HUMAN FACE occur in *Phil. Trans.* 1868. Those of most interest are in connection with the development of the superior and pre-maxillaries. He describes in a human fœtus 2·3 in. long a process which projects forward from the base of the nasal process, which he calls the *incisor* process. In a fœtus 4·3 the incisor process passes across the anterior boundary of the nostril, as the latter is continued forward to the middle of the lip. This boundary is partly covered above by the nasal process, whilst below the palatal part of the superior maxilla ends abruptly behind it, and between these two the incisor process crosses and indents the orifice of the nostril. In a fœtus 2·3 the pre-maxilla consists of deposits of bone formed in a membrane situated about the posterior edge of the incisor process, which deposits subsequently grow down to form the plate of bone on the inner side of the middle incisor socket and the posterior wall of the incisor sockets below and internal to the course of the incisor branches of the dental nerve. In a fœtus 4·3 the pre-maxilla is completely formed and may be traced as a distinct bone. In one 9 inches long it is in great part fused with the superior maxilla, though the well-known palatal fissure marks its position inferiorly. The pre-maxilla therefore in man is shut off from the face by the nasal and incisor processes of the superior maxilla.——H. v. Luschka applies (*Reichert u. du Bois Reymond's Archiv*, 1869, p. 326) the name of PROCESSUS MARGINALIS to a process which in many malar bones projects backwards from the posterior free temporal border. He regards it as an individual peculiarity and not a race character, for in 82 dolicocephalic skulls it was present in one half, and in 48 brachycephali it was present 26 times. ——Since the appearance of the note on the ADDITIONAL CARPAL BONE, by J. Struthers, in our last number, W. Gruber has recorded cases (*Reichert u. du Bois Reymond's Archiv*, 1869), in one of which in the left carpus a very small ossicle was situated between the bones of the 1st and 2nd rows in an interval between the scaphoid, trapezoid and os magnum. This differed from one he had described in the same *Archiv* in 1866, in which the 9th carpal bone occurred in the 1st row and seemed to be derived from a subdivision of the scaphoid into two secondary bones. In a third case, *Archiv* p. 343, the 9th ossicle was, as in Dr Struther's specimen, situated between the trapezoid, os magnum, 2nd and 3rd metacarpals, and was only visible on the dorsal aspect; but it was joined to the trapezoid by synchondrosis: the

[1] To assist in making this Report more complete, Professor Turner will be glad to receive separate copies of original memoirs, or other contributions to Anatomy.

styloid process of the 3rd metacarpal was absent. In a fourth case he has seen this styloid process developed from an independent centre and constituting a 9th carpal bone. He arranges the supernumerary carpal bones under the following varieties: *a.* subdivision of the scaphoid or semilunar: *b.* intercalation of a supernumerary bone analogous to the os intermedium of the mammalia: *c.* a defect in the styloid process of the 3rd metacarpal and a separation of the coincidently enlarged trapezoid into two pieces: *d.* the occurrence and persistence of the styloid process of the 3rd metacarpal as a distinct epiphysis.——An elaborate memoir on SUPERNUMERARY CERVICAL RIBS, by the same author, is in *Mém. de l'Acad. Imp. de St Pétersbourg*, Oct. 28, 1868, which the Reporter has given an abstract of on pp. 137—139.——Hugo Magnus has seen (*Virchow's Archiv*, XLVII. 214) two crania in which the SPHENOIDO-MALAR SUTURE did not exist in the outer wall of the orbit, but the great wing of the sphenoid and orbital process of the malar were separated from each other by a fissure.——An abstract of a memoir by John Cleland ON THE VARIATIONS OF THE HUMAN SKULL, PARTICULARLY IN THE ANTERO-POSTERIOR DIRECTION, appears in *P. R. S. London*, June 15, 1869. A base line extending from fronto-nasal suture to back of foramen magnum is the longest in savage skulls: he subdivides this line into three parts; one the length of the foramen magnum, one from fronto-nasal suture to foramen opticum, one intermediate from foramen opticum to foramen magnum. The long base line of savages is due to the amount of orbital length and to that of the intermediate part of the base line. The line of orbital length forms with the foramen magnum an angle termed the cranial curvature, which in adult Europeans usually exceeds 180° and in negro and other savages falls short of that amount. The parietal region reaches its greatest predominance in the last month of fœtal life, after birth the frontal region grows most rapidly, then the occipital. It is not correct to say, that as far as mesial measurements are concerned the forehead is less developed in the lower than in the more civilized races. The distinction between dolicocephali and brachycephali should be based not merely on the 'cephalic index' but on the various characters pointed out by Retzius. The proportion of height to length is of more importance than breadth to length. Orthognathism and prognathism are concrete results of a variety of circumstances, and the extent of facial projection must be measured by an angle contained between the fore part of the face and the floor of the anterior fossa only of the skull. ——T. Zaaijer describes (*Nederl. Tijdsch. voor Geneesk.*, 1869) an ANOMALOUS CONDITION OF THE 1ST AND 2ND RIBS in a man, aged 43, where the shaft of the 1st rib was atrophied in its anterior half, its place being taken by a fibrous band, which reached to the manubrium; whilst the 2nd rib had a considerable tuber projecting from its shaft, with which the anterior end of the osseous part of the first rib was connected. He refers to corresponding anomalies of the upper ribs recorded by J. Struthers, von Luschka and Aeby.——To the *Gesellschaft der Wissensch. zu Haarlem*, 1866, T. Zaaijer communicates an important memoir on the FORM OF THE PELVIS OF THE WOMEN OF

JAVA, 26 specimens of which he had examined. His general conclusions are as follows: the pelvis has an elegant shape; the surface of the iliac fossa is smaller than in the pelvis of European women and almost always has a translucent spot; the ilia incline for the most part strongly outwards and are very flat; the *præ-auricular sulcus* to which the anterior sacro-iliac ligaments are attached, and which is wanting, or only feebly developed, in the European pelvis, is met with in most of the Java pelves; the *linea arcuata interna* is not sharp, but rounded; the ischial spines project strongly inwards in most Java female pelves; the sacrum varies in shape but is absolutely less broad than in Europeans; the pelvic inlet is either round or longish-oval; the difference between the transverse and conjugate diameter of the pelvic inlet is less than in Europeans; the promontory is less projecting: in the specimens examined no connection between the form of the cranium and that of the head was observed. The memoir is illustrated by plates and copious tables of measurements.——A. Kölliker gives a brief description (*Verhand. der phys. med. Ges.* Würzburg, May 22, 1869) of the character of the CRANIA of the SOUTH SEA ISLANDERS AND THE AUSTRALIANS. He had examined 9 crania of the former, mostly from the Feejee Islands, and 3 crania from Rockhampton on the East Coast of Australia. He refers in both series to specimens in which the two nasal bones were blended together.

CONNECTIVE TISSUE AND CARTILAGE.—L. Ranvier publishes in *Archives de Phys.* No. 4, 1869, an important memoir on the CELL-ELEMENTS OF THE TENDONS AND AREOLAR TISSUE. His observations lead to the following conclusions: the connective tissue is essentially formed of connective bundles, of elastic fibres and of cells. Neither laminæ nor holes can be observed in it. The bundles of the connective fibres are cylindrical, they have a very variable diameter, they are limited by a special layer of annular or spiral fibres. These fibres appear to be a simple thickening of the membrane, thus they are coloured by carmine and differ therefore from elastic fibres. All the cells are formed of granular protoplasm and contain well-formed nuclei. These cells are placed between the bundles of connective tissue: some, globular in shape, appear capable of moving easily in the spaces left between the bundles: other cells, flattened, take up a position along the bundles which they do not easily quit. The stellate cells (*cellules plasmatiques*) seen in transverse sections of dried tendons, are situated at a point where many of the bundles come in contact, and at that spot a nucleus surrounded by protoplasm is situated in a space limited by the exterior of the bundles: the bundles cut transversely form a network-like arrangement, and Ranvier believes in the existence of a canalicular network in which the cells are included. He believes in the existence of a plasmatic circulation in the connective tissue and, from the presence of cells like the white blood-globules, conceives it to be a true lymphatic circulation, and he suggests the existence of a great space between the bundles of the sub-cutaneous connective tissue analogous

to a serous cavity.——R. Boehm relates (*Virchow's Archiv*, XLVII. 218) his experimental enquiries into the STRUCTURE OF THE DURA-MATER, with reference to the existence of pores or stomata on its free surface opening into the arachnoid space, similar to those which Recklinghausen and Dybkowsky have described in connection with the peritoneum and pleura. He has satisfied himself that such pores exist, and that whilst they communicate on the one hand with the arachnoid cavity, on the other they open into a system of large juice-canals, situated in the connective tissue of which the dura mater is composed, which canals again communicate with the veins, which form a rich network on the outer surface of the membrane. Milk injected into the arachnoid space found its way through the stomata and juice-canals into the venous system.——N. Bubnoff contributes (*Sitz. der K. Akad.* Wien, 30 April 1868) observations on the VASCULARITY OF CARTILAGE. He states that both in young and adult animals and in man blood-vessels exist, which lie in especial canals in the cartilage. He refers to statements made by Reitz in the *Sitzungsb.*, Jan. 1868, of the presence of juice-canals in cartilage, and he considers that by treating fresh cartilage with chloride of gold and osmic acid he has proved the existence of juice-canals in this tissue. On this subject also the Reporter may refer to the observations of T. A. Carter, communicated to *R. S. London* in 1864, and printed *in extenso* in the present number of this *Journal*.——M. Peyraud (*Archives de Phys.* No. 5, 1869), from experiments made on rabbits and dogs, concludes that the COSTAL CARTILAGES CAN BE REGENERATED after removal.

MYOLOGY.—Wenzel Gruber describes several VARIATIONS IN THE MUSCLES OF THE WINDPIPE (*Reichert u. du Bois Reymond's Archiv*, 1868): a *m. Kerato-arytænoideus*; which arises from the posterior border of the inferior horn of the thyroid cartilage and is inserted into the muscular process of the arytænoid cartilage; this muscle is very rare: a variety of the *m. thyreo-trachealis*, which arises by two heads from the thyroid cartilage in front of the attachment of the crico-thyroid, descends anterior to the isthmus of the thyroid body, ends in an aponeurosis which blends with the perichondrium at and below the 4th tracheal ring: a *m. hyo-trachealis*, which arises from the anterior part of the great cornu of the hyoid and descends superficial to the *m. thyro-hyoideus* to be inserted into the tracheal rings from the 1st to the 3rd: a *m. incisuræ mediæ transversus*, which arises fleshy from the half of the incisura media and the process of the lower border of the thyroid cartilage on the one side and is inserted into the corresponding parts on the other: a *m. incisuræ mediæ obliquus*, which has somewhat similar connections with the last, but is more oblique in its direction, this obliquity varying in the different specimens in which it has been seen.——Gustav Fritsch records a variety in the MUSCULAR ARRANGEMENTS IN THE AXILLA (*Reichert u. du Bois Reymond's Archiv*, 1869), where on the right side one bundle passed from the latissimus tendon outwards over the coracobrachialis to be connected to the fascia: a second passed from this fascia to

the interval between the great pectoral and latissimus: a third bundle extended from the latissimus tendon horizontally forward to be inserted into the superficial layer of the axillary fascia.——John Wood communicates (*P. R. S. Lond.* June 17, 1869) a memoir on VARIETIES OF THE MUSCLES OF THE NECK, SHOULDER AND CHEST, which comprises an account of the *occipito-scapular*, *levator claviculæ*, *cleido-occipital*, *sterno-scapular*, *scapulo-clavicular* and *supra-costal*, and of certain transitional forms; together with an account of the muscles homologous to them in the mammalia.——C. Blumenthal records (*Henle u. Pfeufer's Zeitsch.* XXXVI., a variety of the right M. TRICEPS EXTENSOR CUBITI, in which a fourth head arose by a long slender tendon from the inner part of the humerus a little below the head and by an aponeurotic expansion from the capsule of the shoulder-joint: it passes down to blend by its muscular belly with the inner part of the triceps.——T. Zaaijer describes (*Nederld. Tijdschrift voor Geneeskunde*, 1869) a specimen in the left arm of a woman, of the M. RADIO-CARPOMETACARPEUS, the *Fl. carpi radialis brevis* of John Wood. Taking its rise from the lower end of the radius it was inserted into the transverse carpal ligament, the trapezium and the carpal ends of the 2nd, 3rd and 4th metacarpal bones.

In an account of the structure of a uterine myoma, H. Hertz (*Virchow's Archiv*, XLVI.) describes and figures, as Frankenhauser had previously done in the uterine muscular fibres (see Vol. II. p. 389), the termination of the fine nerves in the nuclei of the muscular fibro-cells.

Fritz Ratzel contributes (*Siebold u. Kölliker's Zeitschrift*, XIX. 257) the 1st part of a memoir on the histology of the lower animals. It contains an account of the *muscles* of lumbricus, tubifex, limnodrilus, enchytræus, lumbriculus, nais, chætogaster. He arranges them in 3 groups: *a. nematoid* muscles, closely allied to the muscles of the nematodes as they have been described by Schneider and Weissmann; *b. hirudinoid* muscles, the fibres of which present a sharp subdivision into a granular axial and a homogeneous cortical part; *c. simple* muscular fibres, ribbon-shaped, more or less flat elements, in which no such subdivision is recognisable. He has seen in neritina fluvialis muscular tissue consisting of primitive bundles with transverse striæ. In the same *Zeitschrift*, Anton Schneider remarks on the *muscles of nematodes*, and H. Grenacher on the *muscles of Gordius*.——In *Schultze's Archiv*, v. 205, G. Schwalbe prints a lengthy memoir on the STRUCTURE OF THE MUSCULAR FIBRES OF THE INVERTEBRATA. He has examined their structure in Coelenterata, Echinodermata, Annelides and Mollusca.——M. A. Quatrefages describes and figures (*Ann. des Sc. Nat.* XI. 1869) the MUSCLES IN ANNELIDES.

BLOOD-VASCULAR SYSTEM.—P. Gillette gives an account (*Robin's Journal*, Part v. 1869) of the VEINS OF THE BLADDER and the INTRA PELVIC VENOUS PLEXUSES. He considers that the vesical veins are arranged in 3 layers, a mucous, inter-muscular and sub-peritoneal. He

arranges the veins of the mucous layer into those connected with the body of the bladder, near the neck and at the base and orifices of the ureters. The sub-peritoneal veins he arranges as anterior, lateral and posterior. The pelvic plexuses are pubo-vesical, vesical or vesico-prostatic, prostatic, and the plexus around the vesiculæ seminales and vasa deferentia.——E. Seseman describes the CONNECTIONS OF THE ORBITAL VEINS (*Reichert u. du Bois Reymond's Archiv*, 1869, p. 154). He disputes the view usually held, that the greater part of the blood in the orbit is carried away by the ophthalmic vein into the cavernous sinus, and whilst admitting that in most cases it may flow both into the sinus and facial vein, yet holds that the latter is the chief outlet. The *V. ophthalmica inferior* is an emissary for the cavernous sinus: it opens either into the *V. ophthalmica superior*, or into the *V. opthalmo-meningea* or the cavernous sinus, and has in the first of these cases a valve at its mouth. The *V. ophthalmica superior* has no valves and its canal is narrowed where it joins the cavernous sinus. The *V. centralis retinæ* opens direct into the cavernous sinus, once he saw it end in the *V. ophthalmica inferior*. The ophthalmo-meningeal vein of Hyrtl opens either into the sinus spheno-parietalis of Breschet, or passes above it into the orbit. The vein is rich in valves, which lie so as to prevent the centrifugal movement of the blood.——P. D. Handyside points out (*Proc. R. S. Edinb.* Feb. 15, 1869) in the HEART traces of its TRANSITIONS IN FORM DURING FŒTAL LIFE. He describes a large reticulated Eustachian valve extending to $\frac{3}{16}$th inch from the entrance of the sup. v. cava: also a male fœtus in which a *complete* semilunar valve was situated at the termination of the v. cava superior, and refers to the parallel case previously described by the Reporter (see our last number, p. 453): also a specimen in which five large Thebesian foramina opened into a deep lacuna at the rim of entrance of the v. cava sup. An oblique semilunar valve guarded this lacuna.——T. Zaaijer (*Nederl. Tijd. voor Geneeskunde*, 1869) describes a RIGHT AND A LEFT SUPERIOR VENA CAVA in a woman aged 77: and a specimen from a man in which the LEFT COMMON ILIAC V. close to its termination gave off a large loop-like branch, which joined the left renal V.; the iliac V. passed superficial to the right iliac artery on its course to form the V. cava inferior. Irregularities in the right kidney and ureter existed in the same individual.

STOMACH AND SPLEEN.—An important paper on the POSITION AND RELATIONS OF THE STOMACH AND SPLEEN by H. von Luschka appears in *Prager Vierteljahrschrift*, I. p. 114, 1869.—The stomach lies only in the left hypochondrium and epigastrium. The hypochondriac part embraces three-fourths of the organ and is almost *vertical* in position, whilst the epigastric part is transverse and corresponds in the distended organ to the two first lumbar vertebræ, crossing about three fingers' breadth below the ziphoid cartilage; great curvature mostly looks to left wall of chest, but a small part lies in epigastrium and corresponds in the distended stomach to upper border of third lumbar v.; small curvature runs downwards in a line with left border of sternum and is mostly concave to the right, but where

pylorus passes into duodenum is convex; œsophageal opening corresponds to upper fourth of 7th costal cartilage and does not lie in epigastrium; great cul-de-sac does *not* lie to left, but is the highest part of the organ; after a moderate expiration it corresponds to upper border of 5th rib in mammary and upper border of 6th in axillary region. Pylorus does not pass to right costal arch, and extends no further than a line drawn vertically parallel to right border of sternum. 1st part of duodenum is not transverse, but runs directly from before backwards. The pancreas lies behind pylorus and transverse part of small curvature, and then crosses vertical part of small curvature. The back of the stomach is in relation to spleen, pancreas, kidney and supra-renal capsule; posterior surface of great cul-de-sac lies on the diaphragm. The spleen corresponds to the curvatures of 9th, 10th and 11th ribs; its greatest breadth is from upper border of 9th to lower border of 11th; its direction is from behind and above, obliquely downwards and forwards. It lies altogether *behind* the stomach.

SECRETING GLANDS.—E. Pfluger publishes (*Schultze's Archiv*, v. 193) a second memoir on the TERMINATION OF THE NERVES IN THE SALIVARY GLANDS. His observations were made on specimens steeped in perosmic acid, which stains the medullated nerves black, without giving an appreciable tint to the gland substance. By this mode of examination he has satisfied himself of the correctness of his former well-known observations. At p. 199 he relates his observations on the NERVES OF THE PANCREAS, a gland which has the same general structure as the salivary glands, only that its alveoli are usually larger, its epithelial cells less sharply separated from each other, and, when treated with perosmic acid, their protoplasm is also fibrillated, the direction of the striæ being from the *memb. propria* to the canal of the gland. An extraordinary number of medullated nerve-fibres exist in this gland, which frequently divide, especially towards their termination. They closely resemble the nerve-fibres in the brain and spinal cord. The primitive fibres pierce the *memb. propria*, lose the medullary sheath almost entirely, and become connected with the epithelial cells.——In an article ON THE CONNECTIVE SUBSTANCE FOUND IN GLANDS in the same vol., p. 334, Dr. Boll records his observations on this structure in the salivary and lacrymal glands, pancreas, liver and kidney.——G. Saviotti investigates (*Verhand. der phys. med. Gesellschaft*, Würzburg, May 22, 1869) the STRUCTURE OF THE PANCREAS with reference to the existence of intercellular passages between the secreting cells within the acini. He describes an arrangement not unlike that which Hering, Kölliker, Eberth and others (see Report, Vol. II. p. 171) have described in the liver: a fine network capable of being injected, forming polygonal meshes in each of which a single gland-cell is situated, this network comes close to the membrana propria; a central canal exists in many though not in all the acini. Saviotti also describes fusiform cells with two, three or even more processes situated within the acini of the gland, and in the main agrees with Langerhans in his account of these structures.

NEUROLOGY.—The TOPOGRAPHY OF THE CEREBRAL CONVOLUTIONS has recently been discussed by Th. Bischoff (*Abhandl. der K. Bayer. Akad.*, Munich, 1868) and by Alex. Ecker, *Pamphlet*, Brunswick, 1869. The development of the brain has also been enquired into by Bischoff in his Memoir, and by Ecker in a separate Essay (*Archiv für Anthropologie*, 1869). Both authors adopt the plan now usually followed of subdividing each hemisphere into five lobes, frontal, parietal, occipital, temporo-sphenoidal and the insula; but they differ in some of their descriptive details. Bischoff for example follows Gratiolet in placing the *gyrus centralis anterior* in the parietal lobe, whilst Ecker, adopting the method pursued by the Reporter in his essay on the cerebral convolutions, places it in the frontal lobe. Both Bischoff and Ecker criticise the figure and description given by the Reporter of the ascending limb of the Sylvian fissure, but in the brain, from which Fig. 1 in the Reporter's essay was taken, the arrangement of the fissure was as is represented. Neither Bischoff nor Ecker seem to allow for the variations met with in different brains in the mode in which the inferior frontal gyrus springs from the ascending frontal gyrus, variations which materially modify the extent and relations of the ascending limb of the Sylvian fissure and the antero-parietal sulcus. Bischoff applies new names to some of the convolutions of the parietal lobe: the supra-marginal lobule he terms the anterior arched convolution; the angular gyrus the middle; the 3rd and 4th annectent gyri the posterior; the 1st annectent the internal superior, and the internal inferior annectent gyrus the internal inferior parietal arched convolution. Bischoff also expresses his inability to admit the intra-parietal fissure which the Reporter described in the parietal lobe, a circumstance which is the more surprising as this fissure is very accurately represented in various of the coloured drawings of the brain with which Bischoff's memoir is illustrated. Ecker however recognises the importance of this fissure both in the fœtal and adult brains, and carefully describes it. Ecker gives a minute description of the occipital lobe and of its connections with the parietal and temporo-sphenoidal. Ecker's memoir on the development of the convolutions and fissures is excellently drawn up and is illustrated by numerous figures. Bischoff enters into a comparison of the brain of the ape with that of man. He states that the primary convolutions and fissures in the human brain exist also in the orang, but he doubts if both brains go through the same developmental changes, or that the former is merely to be regarded as in a higher stage than the latter; much more is he satisfied that whilst both brains possess the same base-type, yet that they pursue different directions in their development, and at no time completely correspond with each other.——An abstract of a memoir ON THE STRUCTURE OF THE CEREBRAL HEMISPHERES by W. H. Broadbent is in *P. R. S. Lond.*, June 17, 1869. He examined the brain after hardening it in strong spirit. He states that the commissural connection between different parts of the hemisphere is much more extensive than has hitherto been described, and that the fibres more

commonly run longitudinally in the convolutions than cross from one to another, while large tracts of convolutions have no direct connexion with the crus, central ganglia or corpus callosum, and the preponderance of commissural over radiating fibres is shown by a comparison of the sectional area of the latter as they issue from the central ganglia with the large surface of white matter seen in the centrum ovale. He then proceeds to detail the result of his dissections, which will not allow any briefer abstract than the author has himself given.——J. M. Strachan, in his *Graduation Prize Thesis* (Edinburgh, 1869) on the HISTOLOGY OF THE CEREBELLUM, records the results of a microscopic examination of the cerebellum in 10 species of mammals, 32 birds, 2 reptiles and 3 fish. He found an uniformity in the elementary structures in all the cerebella examined. But the corpus dentatum in several birds, instead of presenting in a vertical antero-posterior section the appearance of a corrugated pouch, was seen to consist of nerve-cells scattered throughout the medullary portion of the cerebellum. The folia also differ greatly in number, form, and relative length and breadth. Speaking generally the number increases in the mammalia with the development of the lateral hemispheres, whilst in the lower classes of the vertebrata the number depends on the degree of development of the median lobe. The number, size and complexity of the folia are apparently in direct proportion to the variety and complexity of the movements which the animal performs. There is no great difference in the absolute and relative thickness of the inner and outer grey layers. From a measurement of 38 cerebella with the micrometer it appears that whilst in man the two layers are of equal thickness, in all the others the outer layer is the thicker of the two, except in the Bishop bird of South Africa. The characteristic structures in the inner layer are not free nuclei, but each nucleus is surrounded by a differentiated mass of protoplasm. Gerlach's views of the connexion of these structures in the inner layer with nerve filaments, passing between and into them, are so far confirmed as that in the cerebellum of a monkey nerve filaments were seen continuous with the processes of these nucleated masses of protoplasm. The cerebellum of a mule (between linnet and canary) is identical in structure with that of a linnet and of a canary, in which the sexual activity was not impaired, an observation which is antagonistic to the theory of the sexual function of the cerebellum.—H. Hadlich describes (*Virchow's Archiv*, XLVI.) a varicose condition of the CENTRAL PROCESS OF THE CORPUSCLES OF PURKINJE IN THE GREY MATTER OF THE CEREBELLUM. He was enabled to trace in several cases the continuity of this process with a medullated nerve-fibre in the rust-coloured granular layer.——A. Koschennikoff (*Schultze's Archiv*, v. 332) has also seen in two instances IN THE GREY MATTER OF THE CEREBELLUM the thin process, which extends from the corpuscle of Purkinje towards the inner rust-coloured layer, directly continuous with the axial cylinder of a medullated nerve fibre. He has never seen this process branch or become connected with the granules of the rust-coloured layer. At p. 374 of the same vol., he states that in the cerebrum of a man who

died with abscess in the brain, he found it possible to isolate the nerve-cells with long processes in the grey matter of the convolutions. In one instance he saw a process from the basal part of one of the large pyramidal nerve-cells of the frontal lobe pass centrally to be continuous with a medullated nerve-fibre: four other processes passed off from the base of the same cell, which subdivided into minute branches but were not continuous with nerve-fibres. The author does not seem to be aware that Lionel Beale, *P. R. S. Lond.* June 18, 1863, describes each nerve-cell of the grey matter as connected with at least two nerve-fibres.——Rudolf Arndt publishes (*Schultze's Archiv*, v. 317) a 3rd memoir on the CONSTRUCTION OF THE CEREBRAL CONVOLUTIONS, which like the 2nd is chiefly devoted to the structure of the nerve-fibres and cells. The brain of the rabbit was specially examined. The nuclei and surrounding granular fibrous substance, which constitute the neuroglia of most authors, are the matrix out of which all the nervous structures, both ganglion bodies and fibres, met with in the central organs, proceed. The central processes of the ganglion bodies branch in the granular fibrous substance, whilst the *peripheral* are connected with the axial cylinder of the nerve fibres. He regards the interganglionic granular fibrous substance, or the terminal fibrous network as it appears in the adult, as protoplasm modified for a special purpose, as the proper conductor of all the processes which take place centrally.——M. Roth enters (*Virchow's Archiv*, XLVI.) into the nature of the CONNECTIVE SUBSTANCE IN THE CEREBRAL CONVOLUTIONS, and describes the lymph space, which surrounds the arteries and even the capillaries of the brain, as traversed by extremely delicate radiating fibres. Similar fibres may be seen between the pia mater and most superficial nervous layer traversing the space termed by His epi-cerebral.——R. Lepine also describes the CONNECTIVE TISSUE IN THE PERIVASCULAR CANALS (*Archives de Phys.* No. 3, 1869). He states that a delicate filamentous tissue connects the tunica adventitia of the blood-vessels of the brain with the hyaline membrane which limits the canal externally. In certain pathological conditions in children the cell-elements of this connective tissue, which are few in number in the normal state, abundantly proliferate.——J. M. Philipeaux and A. Vulpian state (*Archives de Phys.* No. v. 666) that the ANASTOMOSIS BETWEEN THE SUPERIOR AND INFERIOR LARYNGEAL NERVES consists exclusively of a branch proceeding from the first of these nerves.——F. Jolly records a case of IMPERFECT DEVELOPMENT OF THE CORPUS CALLOSUM (*Henle u. Pfeufer's Zeitsch.* XXXVI. 4).

EYEBALL.—David Smith describes the STRUCTURE OF THE ADULT HUMAN VITREOUS HUMOUR (*Lancet*, May, and *Monthly Micros. Jnl.*, July, 1869). He has sometimes seen, in the adult, traces of the hyaloid canal, which gives passage to the embryonic hyaloid vessels: eight or ten concentric circles formed of strong, smooth fibres arise at right angles from and surround the inner surface of the zonule of Zinn: they are directed backward to the entrance of the hyaloid canal and subdivide the entire circumference of the humour

into shallow horizontal spaces, which build up layer on layer the sides of the vitreous body. In the spaces between these smooth fibres, and in the part of the humour which lies behind the lens, an anastomosing cell network lies, the filaments of which cross the short diameter of the spaces and have a radiating direction from the vertex to the sides of the vitreous body.——Henry Lawson communicates the 1st part of an essay ON THE ANATOMICAL RELATIONS OF THE CILIARY MUSCLE IN BIRDS (*Monthly Micros. Jnl.*, Oct. 1869). He regards it as forming not so much a ring as a zone of muscular tissue, the fibres of which pass forwards to the line of junction of the cornea and sclerotic, and backwards for some lines between the sclerotic and choroid. The fibres are inserted into the sheath of the muscle at its anterior extremity and the inner lamina of the cornea, whilst they arise mostly from the sclerotic, but in part from the choroid. The fibres are striated, and the author considers that it does not act through the choroid on the lens, but on the border of the cornea, and thus increases the curvature of the latter.——A valuable course of lectures on the MINUTE ANATOMY OF THE EYE-BALL, delivered by J. W. Hulke in the theatre of the College of Surgeons, illustrated with numerous original drawings, appears in the *British Medical Journal*, commencing July 3.

MISCELLANEOUS.—F. E. Schulze communicates his observations (*Schultze's Archiv*, V.), on the FORMATION OF THE CUTICLE and the conversion of the epithelial cells into horny tissue.——C. L. Heppner enters (*Virchow's Archiv*, XLVI.) into the discussion of the STRUCTURE OF THE GLANDULA CAROTICA, a body which, like the coccygeal gland of Luschka, has had its structure very much canvassed of late years. Heppner's dissections in the main bear out the views which Luschka published in 1862.——In *Robin's Journal*, Parts 4 and 5, 1869, M. Grandry records his observations on the corpuscles of Pacini, and on the termination of the nerves in the skin, and E. Goujon describes tactile corpuscles in the bill of the parroquet.

MALFORMATIONS.—Hugo Magnus describes (*Virchow's Archiv*, XLVII. 307) a case of CONGENITAL MALFORMATION OF THE MALE URETHRA, in which the tube, just within the external orifice, was subdivided into two canals by a horizontal membranous septum. The lower canal was the proper urethra. The upper had the aspect of a fossa lined by mucous membrane, and at its lowest part was a small aperture, which opened into a *cul-de-sac*.——Wenzel Gruber describes (*Virchow's Archiv*, XLVII. 303) MALFORMATION OF THE FINGERS in a man in whose right hand the middle and little fingers had a circular constriction; in the middle around the 1st phalanx, in the little around the joint between the 1st and 2nd. The ring-finger again had only the 1st phalanx. In the left hand the phalanges of the 3rd finger were wanting, and the ring-finger had only a single phalanx. In the same Vol., p. 304, he records a case of MALFORMED FOOT, in which only four toes (great, small, and two intermediate) existed, and in which the ecto- and meso-cuneiform were blended into

a common bone. In Vol. XLVII. he relates a case of CONGENITAL DIAPHRAGMATIC HERNIA, in which the jejuno-ileum and ascending colon had a common mesentery.——Otto Obermeier relates a case of CONGENITAL FISSURE OF THE STERNUM (*Virchow's Archiv*, XLVI. p. 209), which corresponds in many respects with the well-known case of E. Groux.——Ed. Thorner describes a fœtus (*Reichert u. du Bois Reymond's Archiv*, 1869, p. 200), in which DEFECTIVE FORMATION OF THE AMNION was conjoined with other malformations.—— In the same Vol., p. 267, Dr Preuss relates a case of DOUBLE MONSTROSITY, where a child had a tumour over the sacral region, in which parts of a second fœtus were contained.——H. v. Luschka describes (*Virchow's Archiv*, XLVII. 378) a specimen of CONGENITAL MALFORMATION OF THE ESOPHAGUS, in which its cervical part ended in a *cul-de-sac*, whilst its thoracic part opened into the trachea. The case closely resembles one described by T. Annandale, and referred to in our last report (p. 456).——Julius Arnold records (*Virchow's Archiv*, XLVII. 7) the dissection of a 7 months' fœtus in which there was a UTERUS MASCULINUS, together with congenital stricture of the urethra, and extreme dilatation of the bladder and ureters.—— H. Hertz describes (*Virchow's Archiv*, XLVI.) a case of extreme ATROPHY OF THE LEFT KIDNEY, conjoined with congenital narrowing of the corresponding renal artery.

EMBRYOLOGY.—E. B. Truman gives an account (*M. Mic. Jnl.* Oct. 1869) of the DEVELOPMENT OF THE OVUM OF THE PIKE.——R. Buchholz describes (*Siebold u. Kölliker's Zeitsch.* XIX. 95) the DEVELOPMENT OF ALCIOPE, and in the same Vol. Claparede and Mecznikow contribute to the history of the DEVELOPMENT OF THE CHÆTOPODA; F. Raetzel to that of LUMBRICUS AND NEPHELIS, and Pagenstecher records a new mode of DEVELOPMENT IN THE SIPHON-OPHORA.—— In *Schultze's Archiv*, V., A. Schneider gives an account of the DEVELOPMENT OF THE BRYOZOA AND GEPHYRÆA, and at p. 356 Rieneck records observations on the LAMINATION OF THE GERMINAL MEMBRANE in the egg of the trout.——Waldeyer distinguishes (*Schlesische Gesellschaft für vaterl. cultur.*, May 7, 1869) from the very commencement a subdivision of the WOLFFIAN BODIES into a sexual and a urinary portion. The canals of the latter are broad, and contain a more opaque granular epithelium. Between them narrower canals, with paler epithelium belonging to the sexual part, are situated, and these grow in both sexes towards the genital glands, and sink more or less deeply into their stroma. There is in all the higher vertebrata a stage where the genital gland is invested with germinal epithelium (*Keim-epithel*), in which the first indications of ova are visible, whilst at the same time the paler canals, already referred to in the Wolffian body, penetrate into the stroma of the genital gland. These canals in their further development become seminal tubes, whilst those lying outside form the epididymis. In the stroma of the hilus of the ovary of the dog, the remains of seminal tubes may be recognised, so that the sexual organs of the higher vertebrata are in their early condition hermaphrodite.——M. A. Lafont (*Ann. des*

Sc. Nat. XI. 1869) records his observations on the FECUNDATION OF CEPHALOPODA, and M. Balbiani has in the same Vol. a memoir on the GENERATION OF APHIDES.

COMPARATIVE ANATOMY AND MORPHOLOGY.—H. Magnus records (*Reichert u. du Bois Reymond's Archiv*, 1869, p. 207) his anatomico-physiological observations on the THORACIC AND ABDOMINAL MUSCLES OF BIRDS. He describes in detail their attachments, and examines their actions, more especially with regard to their influence on the respiratory movements. The muscles of birds he thinks supply an additional argument to those advanced by Henle, of the inspiratory action of both sets of intercostals. The scalenus primus is absent in some birds, as the Corvini, Psittacini; and when present in other birds it is weak. He describes a new muscle, sterno-costalis superior, passing from the sup. lateral process of the sternum to the last cervical rib, and regards it as an inspiratory muscle. The serratus major compensates for the want of levatores connected with the lower ribs. The abdominal muscles are limited in their action to emptying the abdominal viscera, the external oblique alone to any extent acting on the chest.——A. Macalister gives (*Ann. Nat. History*, July 1869) a detailed account of the MYOLOGY OF BRADYPUS TRIDACTYLUS, and in the October number of the same *Magazine*, J. C. Galton describes the MYOLOGY OF CYCLOTHURUS DIDACTYLUS or two-toed Anteater.——In the 6th Vol. *Trans. Zool. Soc.* R. Owen gives his 12th memoir on the ANATOMY OF DINORNIS: and at p. 501, W. K. Parker describes the OSTEOLOGY OF THE KAGU (*Rhinochetus jubatus*).——A very elaborate memoir on the ANATOMY OF THE LEMUROIDEA by Messrs Murie and Mivat appears in *Trans. Zool. Soc.* London, VII. They have dissected *Lemur catta*, *varius*, *niger*, *xanthomystax*, *nigifrons*, *Galago crassicaudatus*, *garnettii*, and *allenii*, and in their present memoir, taking *L. catta* as the type, describe the external characters and myology. Their figures however illustrate the anatomy of *Galago crassicaudatus*. The myological description includes not only a detailed statement of the connections of the different muscles, but a careful comparison of their arrangement with those in other Lemuroids, in the Primates and in the lower mammals.——In *Proc. Zool. Soc.* Feb. 25, 1869, J. Murie describes the GULAR POUCH and sphincter muscle in *Otis tarda*. He regards the aperture of the pouch as sublaryngeal rather than sublingual, and that the sphincter is a development of the superior constrictor and stylo-pharyngeus muscles.——In *Robin's Journal*, July 1869, G. Pouchet completes his memoir on the BRAIN OF THE EDENTATA. He considers that the great variety exhibited in the brain in the different groups of these animals is correlated with variations in the outer form of the body, the central part of the nervous system being modified parallel with the other anatomical systems, and concludes from this that the brain and its convolutions cannot form the best basis for a zoological classification.——Ludwig Stieda continues his observations on the CENTRAL ORGANS OF THE NERVOUS SYSTEM, and in this memoir (*Siebold u. Kölliker's Zeitsch.* XIX.) describes those

of several birds, more especially the domestic fowl, and of the mouse.——Miklucho-Maclay, in a letter to Gegenbaur (*Jenaische Zeitsch.* v. H. 1), refers to some points in the BRAIN OF CHIMÆRA MONSTROSA, the great peculiarity consisting in the important extension forward of the cerebral axis (*Hirnstiel*), and the consequent separation of the prosencephalon (*Vorderhirn*) from the di-encephalon (*Zwischenhirn*).——W. H. Flower examines the BASE OF THE CRANIUM in the CARNIVORA, with a view to their classification (*Proc. Zool. Soc.* Jan. 14, 1869). He especially describes the auditory bulla and the structures surrounding it. In *felidæ* and *viverridæ* the bulla is greatly dilated, thin-walled and subdivided into two distinct portions, which communicate by a narrow aperture: in *canidæ* the bulla is smooth and evenly rounded, but the septum subdividing it into two chambers is very incomplete: in *ursidæ* the bulla varies in the amount of inflation, but its cavity is simple, and though traversed by trabeculæ, yet possesses no definite septum. He applies the same method of comparison to the determination of the zoological position of *hyæna*, *proteles*, *arctictis*, and *bassaris*.——J. Murie (*Proc. Zool. Soc.* Jan. 28, 1869) reports on the EARED SEALS of the Falkland Islands, and gives figures of the male and female crania of *Otaria jubata*.——J. E. Gray (*Ann. Nat. Hist.* Oct. 1869) makes some additional notes on the crania of OTARIADÆ.——J. G. H. Kinberg gives (*Öfversigt af Kongl. Vetens. Akad. Forhand.*, Jan. 13, 1869) a careful anatomical description of the OSTEOLOGY of the following species of ARCTIC SEALS: *grœnlandica*, *barbata*, *fœtida*, *vitulina:* in a previous number, Oct. 14, 1868, he enquires into the ossification of the axis in various mammals. He forwards also to the reporter a series of memoirs on the ANNELIDA published in 1865 and 1866 in the same periodical, in which he describes many new species. C. Gegenbaur (*Jenaische Zeitsch.* v. Heft 1) describes the tissue which forms the SKELETON of the CYCLOSTOMATA. In the chorda dorsalis he finds a well-marked intercellular substance situated between large elongated cells, but near the surface the cells are smaller and the intermediate substance more sparing. Next the sheath is a layer of cells which he calls the epithelium of the chorda. The chorda is enclosed in the skeletal layer which gives off dorsal and ventral processes. He considers that the skeletal tissue differs from that of the other vertebrata, and he recognises in it three forms: *a.* the tissue of the skeletogenic layer: *b.* the cartilaginous tissue in the rudiments of ribs: *c.* the cartilaginous tissue of the cranium and gill-sacs.

REPORT ON THE PROGRESS OF PHYSIOLOGY, from 1st April to 1st August 1869. By THOMAS R. FRASER, M.D., F.R.S.E., F.R.C.P.E., *Assistant Physician to the Royal Infirmary, Edinburgh*, ARTHUR GAMGEE, M.D., F.R.S.E., *Lecturer on Physiology at Surgeons' Hall, Edinburgh*, and WILLIAM RUTHERFORD, M.D., *Professor of Physiology at King's College, London*[1].

DR FRASER'S REPORT.

Physiological Action of Medicinal and Poisonous Substances.

BROMIDE OF POTASSIUM.—We have hitherto been chiefly indebted to French and German investigators for our knowledge of the manner in which the physiological effects of bromide of potassium are produced. It is therefore with much pleasure that we direct attention to an extremely valuable and ingenious experimental investigation published by Dr Purser of Dublin, on the action of this remedy (*The Dublin Quarterly Journal of Medical Science*, May, 1869, pp. 321—335). After briefly reviewing the conclusions of Eulenburg and Guttmann, Damourette and Pelvet, and Laborde (see Reports in previous numbers of this *Journal*), Dr Purser states the general results of his own experiments somewhat in the following manner: —After a stage of temporary excitement, which is not however invariably observed, bromide of potassium destroys reflex movement, by an action on the grey matter of the brain and cord. It next destroys sensibility, also by an action on those parts of the nerve centres whose function is to receive and conduct impressions coming from the periphery. The power of voluntary motion is generally retained for a considerable period after the reflex excitability is abolished; but it is likewise eventually lost, and this occurs while the nerves and muscles are yet functionally active. The effect on the heart varies according to the dose and place of injection. If the dose be large and injected in the neighbourhood of the thorax, the heart speedily comes to rest in diastole, before the occurrence of complete suspension of voluntary or even of reflex movement; but if the dose be comparatively small or injected at a distance from the thorax, the heart continues to beat for several hours after movement of every other kind is at an end. The capillary circulation, after a temporary acceleration, becomes slow, and altogether stops before the heart ceases to beat. Respiration is one of the first functions affected, sometimes stopping almost instantaneously on the introduction of the poison; and the respiratory movements of the chest cease before those of the throat. The nerves lose their conductivity at a late period, but muscular irritability is retained for some time after

[1] In order to assist in making this report as complete as possible, the Authors will be glad to receive copies of original contributions to Physiology. Papers for Dr Fraser and Dr Gamgee to be sent to the University, Edinburgh. Those for Dr Rutherford, to King's College, Strand, London.

this. Dr Purser concludes his paper with an account of a few experiments made with bromide of sodium, bromide of ammonium and iodide of potassium, which appear to show that in physiological action these substances differ considerably from each other and from bromide of potassium. The experiments were made on frogs only.

Selenites and Tellurites.—Dr Rabuteau has examined the action of selenite of sodium and potassium and tellurite of sodium (*Journal de l'Anatomie et de la Physiologie*, No. 2, 1869, p. 215). These substances were found to be active poisons. Dogs killed by them died of asphyxia, and the blood was found to contain a crystalline substance, in large quantity. A dose of three grains of selenite of potassium, injected into a vein, killed a dog in sixteen minutes; and, previous to death, an odour of selenetted hydrogen was observed in the breath, proving that this salt is reduced in the system.

Delphinia.—Dr Cayrade (*Journal de l'Anatomie*, No. 3, 1869, p. 317) summarizes the results of his investigations into the action of the alkaloidal active principle of Delphinium Staphisagria, in the following conclusions: 1. Delphinia influences the spinal cord in such a manner as to diminish and then destroy its excito-motor power; 2. This action is produced gradually, and it extends from behind forwards, reflex power disappearing first in the posterior extremities, then in the anterior, and last of all in the head; 3. Voluntary movements continue after the loss of reflex power, but the former become incoordinate before their abolition; 4. Delphinia seems to affect successively the general sensibility, the reflex function, the respirations, and the power of coordinate movements. Its action is restricted to the nervous system.

Picrotoxine.—This active principle of *Menispermum Cocculus* has formed the subject of a recent investigation by Dr Roeber of Berlin (*Archiv v. Reichert und Du Bois Reymond*, 1869, Heft 1, pp. 38—68). He found that in frogs a comatose condition was first produced, and then a series of tetanic spasms, which by and by became clonic. During the stage of clonic spasm, the inspirations were greatly exaggerated, so as abnormally to inflate the lungs; and, on the cessation of each spasm, the air rushed out suddenly with a distinct sound. The heart's action is slowed and the diastole prolonged by picrotoxine. The respiratory movements are at first almost abolished, but they reappear gradually on the disappearance of the spasms. It was found that the occurrence of spasms could not be prevented by removal of the cerebrum or optic lobes; but they never appeared after separation of the medulla oblongata from the m. spiralis. When this operation was performed, picrotoxine produced a comatose condition in which reflex excitability was retained, but no dyspnœac symptoms appeared, and the heart's contractions were increased in frequency. The spasms are therefore dependent on stimulation of the medulla oblongata; and the slowing and even stoppage of the heart's action, as well as the inflated condition of the frog, are caused

by this stimulant action affecting the vagus-centre. Accordingly, when the vagi nerves were divided, picrotoxine exerted a less powerful slowing action on the heart. A certain degree of this action was, however, observed, which Roeber refers to an influence on the cardiac motor-centre, as it could be produced even after the peripheral terminations of the vagus were paralysed by nicotia. Division of the vagi likewise prevented the extreme inflation of the lungs. The activity of the reflex centre is diminished by picrotoxine, and Roeber believes that this effect is due to stimulation of Setschenow's inhibitory centre in the medulla oblongata, for it is not produced after the removal of this centre. The symptoms that appeared in rabbits were the same as those in frogs, only the former animal is more sensitive to the action of this poison than the latter.

APOMORPHIA AND CHLOROCODIDE.—In the course of the elaborate investigations of Dr Matthiessen and Mr Wright on the opium alkaloids, a number of new bases were discovered, among which are apomorphia and chlorocodide (*Proceedings Roy. Society of London*, 1869, pp. 455—462). The former was originally obtained from morphia, but more recently it has likewise been obtained from codeia. In its preparation from the latter alkaloid chlorocodide is formed as an intermediate product. The relationship of these substances to each is illustrated by their formulæ :—

Apomorphia,	$C_{17}H_{16}NO_2 . H$	$= C_{17}H_{17}NO_2$
Morphia, . .	$C_{17}H_{16}NO_2 . H . H(HO)$	$= C_{17}H_{19}NO_3$
Codeia, . . .	$C_{17}H_{16}NO_2 . CH_3 . H(HO)$	$= C_{18}H_{21}NO_3$
Chlorocodide,	$C_{17}H_{16}NO_2 . CH_3 . H(Cl)$	$= C_{18}H_{20} . ClNO_2$

Dr Gee of London has published (*Saint Bartholomew's Hospital Reports*, v. 1869, p. 215) some experiments on the physiological action of these two new substances. He finds that apomorphia is a most powerful emetic and contra-stimulant; and the former action is so invariably produced as to induce him to assert that, to the best of his knowledge, "apomorphia has never been administered in an emetic dose (namely $\frac{1}{10}$ grain subcutaneously or $\frac{1}{4}$ grain by mouth) without producing speedy vomiting." The contra-stimulant effects are not invariably produced, but they are to a slight extent a drawback to the value of apomorphia used as an emetic. Dr Gee supposes that the emetic action is of a kind similar to that produced by "blows upon the head, foul sights or smells, or mere imaginations."(!) The experiments with chlorocodide seem to show that the action of this new base is analogous to that of codeia. It, however, possesses an intense bitterness, almost equal to the bitterness of strychnia, which may lead to its employment in medicine.

MORPHIA AND CHLOROFORM.—In his recent very interesting Lectures before the College of France, Professor Claude Bernard points out some remarkable and valuable effects which may be obtained by combining the actions of morphia and choloroform (*Revue*

des Cours Scientifiques; and *Bulletin Général de Thérapeutique,* 30 Sept. 1869, p. 241). Some years ago, Dr Bernard had occasion to administer a dose of morphia to a dog recovering from the effects of chloroform, and he was surprised to observe that the morphia reproduced the anæsthetic effect of the previous dose of chloroform. More recently, this experiment was modified, so that a dog narcotised by morphia was completely and quickly anæsthetised by a quantity of chloroform very much smaller than would have been necessary to produce this effect in a dog in normal condition. It was further found, that when the anæsthesia had nearly disappeared, a second dose of morphia almost immediately reproduced it. It is well known that anæsthesia cannot be induced by morphia. This alkaloid exalts the sensory excitability, and induces torpor and narcotism: it never destroys sensibility. Chloroform, however, rapidly suspends the sensory excitability. It is, therefore, somewhat remarkable that the anæsthetic action of chloroform should be increased and prolonged by morphia. Dr Bernard believes that this can be explained only by supposing that the action of the one substance is superimposed on that of the other. When an animal is recovering from chloroform-anæsthesia, the quantity present in the blood is insufficient to completely suspend sensibility, although it is sufficient to greatly diminish it; but as morphia blunts the nervous sensibility, it aids the action of the chloroform, and thus a quantity of the latter, in itself insufficient to produce complete anæsthesia, becomes sufficient to do so when assisted by morphia. Bernard points out that this combination admits of several valuable applications, and that, indeed, it promises to be the best method of inducing anæsthesia. By administering a dose of morphia before commencing the inhalation of chloroform, anæsthesia is induced without any initiatory stage of excitement, and without incurring the risk of those accidents, which are occasionally caused by large doses of chloroform.

PHYSOSTIGMA.—Some recent observations by Mr Wharton Jones, F.R.S. (*Practitioner,* September, 1869, p. 160), appear to throw further light on the remarkable action of physostigma. A case of complete paralysis of the third nerve came under his care; and for the purpose of testing the action on the paralysed sphincter pupillæ, some of the extract, in solution, was dropped on the affected eyeball. It contracted the pupil to the size of a pin point, in the usual time; but when this local action had passed off, it was found that the patient had acquired some slight power over the upper eyelid, so as to be able to raise it a little. The application of physostigma was accordingly continued, about one-fourth of a grain being used thrice a week, and at the end of a month the paralysis of the third nerve was completely cured. Mr Jones mentions, by way of contrast, a case of paralysis of the external rectus, in which the local application of atropia effected a cure, probably on account of the stimulating action of atropia on the sympathetic, which is closely connected with the cranial nerve (sixth) supplying the external rectus. The results obtained in these two cases appear to indicate an antagonism between

physostigma and atropia, as regards their effects upon the eye: the former drug stimulating the third nerve, and the latter the sympathetic. Mr Wharton Jones, however, believes that a further and more extensive antagonism exists. He has ascertained that the local application of physostigma to the blood-vessels of the rabbit's ear causes contraction of the *veins;* while the similar application of atropia causes contraction of the *arteries.* (Hitherto, the topical action of physostigma on the circulation has been examined only in the frog's web, where the difficulty of making accurate observations can scarcely be over-estimated. Mr Wharton Jones is the first who has examined this action on the blood-vessels of mammals; and his statements carry the weight due to an authority in such methods of investigation. We hope, therefore, that his experiments will be soon repeated by some other observer.)—Dr Thomas R. Fraser, in a preliminary note (*Proceedings of the Royal Society of Edinburgh*, 31st May, 1869, p. 587), communicated the results of several experiments, which show that physostigma and atropia are antagonistic in their general action, to such an extent that the lethal action of physostigma may be prevented by atropia. For example, a dog received by subcutaneous injection eight grains of sulphate of atropia, and six grains of extract of physostigma. Comparatively slight symptoms were produced, from which recovery occurred in about three hours. Some weeks afterwards, this dog received three grains of extract of physostigma—a dose *only half as large* as that from which it recovered in the former experiment—the usual symptoms of physostigma-poisoning were quickly produced, and death occurred seventeen minutes after the administration.

EMETIA.—Dr Dyce Duckworth (*Saint Bartholomew's Hospital Reports*, Vol. v. 1869, p. 218) publishes some very interesting observations and experiments relating to the action of ipecacuanha and its alkaloid emetia. He employed the pure alkaloid obtained from Messrs Herrings, of which only two grains are yielded by an ounce of powdered ipecacuanha. Péchelier, to whom much of our knowledge of the action of this substance is due, states that poisonous doses produce a diminution in the rate of the respiratory and cardiac movements, and a bleached and exsanguine condition of the lungs. On the other hand, Duckworth observed that the respiratory movements were increased in frequency, and that the cardiac action was not less rapid than in health, while there was always more or less engorgement of the lungs after death, as Magendie had already observed. Duckworth believes, indeed, that there is a similarity in the appearance seen in the lungs of animals who have died of emetia poisoning, and of those whose vagi have been divided. The following theoretical explanation of these effects is advanced. Supposing, as has been enunciated by Professor Rutherford, that the vagus, like most afferent nerves, contains filaments which produce vascular contraction, as well as those which bring about dilation; "we may conceive that the circulation of emetia so affects the peripheral extremities of the vagus, that its vaso-inhibitory branches are thrown into action. From

this there results inaction of the motor branches, and a condition of paralysis, or passive dilatation of the blood-vessels presided over by this nerve." In this manner, the congestions of the lungs and gastro-intestinal mucous tracts (also observed) may be explained. In one experiment, it was found that vomiting was prevented by section of the vagi previously to the exhibition of emetia. We are glad to observe that Dr Duckworth promises to extend his experimental investigation, for our knowledge of the exact physiological action of ipecacuanha, as well as of other extensively employed emetics, is in an extremely unsatisfactory condition.

CURARA.—Professor Paul Bert (*Archives de Physiologie*, No. 5, 1869, p. 650) has made some curious observations on a curarized dog. After paralysis appeared, artificial respiration was started, and continued regularly by means of the ingenious apparatus of M. Gréhant. The right vagus and sciatic nerves were then exposed and tied. During the succeeding six hours, the action of the nerves, the condition of the pupils, &c., were hourly observed, with the following constant results; the pupil of the right side was contracted, while that of the left was widely dilated; galvanization of either vagus caused dilatation of the pupil, with projection of the eyeball and complete stoppage of the heart's action. The left iris contracted under the action of light. An interesting result was obtained when galvanic stimulation was applied to the central portion of the tied (right) sciatic nerve, or to the median nerve: contraction of the bladder, rendered obvious, in the existence of paralysis of the sphincter, by the voiding of urine. This effect could be produced only through the intervention of the sensory nerves of animal life; for it did not follow excitation of the vagi, the sympathics in the neck, nor the splanchnic nerves. The interest of this observation is apparent when its value is considered in explaining certain well-known phenomena, dependent on the relations between the bladder and the sensory nerves, such as the desire to urinate caused by a sensation of extreme cold, or by entering a bath of cold or hot water. In this experiment also Dr Bert discovered the presence of sugar in the saliva.—Dr Roeber has recently studied, with great care, the effects of curara on the electro-motor condition of nerves and muscles (*Archiv v. Reichert und Du Bois Reymond*, 1869, pp. 440—456). He finds that the electro-motor activity of both muscles and nerves is increased by this poison, and that this depends merely on an increased access of blood. The effect is more marked in the muscles than in the nerves, which may readily be explained by the greater supply of blood that is received by the former than by the latter.—In the expectation that permanent functional disturbances and appreciable structural modifications may be thereby produced, Dr E. Goujon made some experiments in which animals were kept for considerable periods under the action of curara (*Journal de l'Anatomie*, No. 2, 1869, p. 207). A lethal dose was injected under the skin of a foot or ear in a rabbit, and when marked paralytic symptoms appeared a ligature was drawn tightly round the part

which had received the poison, and between it and the heart. Absorption was thereby prevented, and on the symptoms disappearing, the ligature was removed, and thus the poison was again permitted to enter the circulation. In this way, several rabbits were curarized daily for many days: but after each occasion a state of perfect normality was resumed as soon as the poison had been completely eliminated. When finally killed, by permitting a fatal dose to enter the circulation, the most careful examination failed in revealing any alteration of structure. Dr Goujon invariably observed that the effects of the same doses were day after day exactly the same in each animal. Curara is not, therefore, one of those poisons in which subsequent doses produce less violent symptoms than those first exhibited. (Dr Goujon does not seem to have specially looked for changes of structure in the motor nerve *end-organs*, where the extraordinary elective action of curara might naturally suggest that such changes are most likely to be met with. We are glad to have an opportunity of stating that Professor Kühne is about to institute an investigation of this kind with curara, salts of methyl-strychnium, &c. F.)

ALCOHOL.—A paper in the *Practitioner* (September, 1869) on the influence of alcohol upon the temperature of the body, may be consulted with advantage. It consists of a summary by Professor Binz of Bonn of recent researches made by several observers, in his pharmacological laboratory. These researches were instituted as a continuation of those of Lichtenfels, Frölich, Tscheschechin, and Möller. The first series of observations was made to determine the effects of very small quantities of alcohol on men and dogs; and it was found that they invariably produced a gradual fall in the temperature, of several tenths of a degree, centigrade. The second series was instituted to determine the effects of large doses. In the experiment described, 25 c.cm. of alcohol, mixed with water, and introduced into the stomach of a strong poodle, caused a fall of about three degrees in less than five hours. When fatal doses were given either to dogs or rabbits a constant fall in temperature also occurred, amounting to between four and five degrees, in from one to two hours, at which time death took place. In the third series of experiments, the effect of alcohol on an artificially produced febrile condition was examined. It was found that the elevated temperature of this condition was decidedly diminished by the administration; and that when this administration was stopped, the febrile symptoms again rapidly rose in intensity. In a final series of experiments, it was determined that the so-called fever of digestion either did not recur at all, or only to a very slight degree, when alcohol was taken. Dr Binz points out how important a confirmation is given by these results to the opinion that alcohol is a valuable and efficient antipyretic. At the same time, the extensive employment of alcohol in acute diseases is to a certain extent opposed by its effects on the pulse and on the tone and diameter of the blood-vessels. In all the experiments, the number and the strength of the

heart's contractions were augmented, and where such effects are counter-indicated alcohol must obviously be an improper remedy to employ. Again, as pus appears to originate in the passage of white cells through the relaxed walls of dilated blood-vessels (Waller, Cohnheim, &c.), alcohol may prove injurious by its dilating action on the capillaries, for it would thus materially favour the formation of pus. Dr Binz attributes the refrigerating power of alcohol to an influence exercised directly on the oxidizing processes that occur in the juices of the body; and not to an influence on the nervous system, or on the means which the system possesses of regulating its temperature by perspiration.

CHEMISTRY AND PHYSIOLOGY.—Dr A. Rabuteau has lately published some results of investigations conducted during several years on the physiological effects of various metals (see the complete abstract of his various papers in his *Journal de l'Anatomie et de la Physiologie*, No. 2, 1869, p. 210). From these investigations, he believes himself to be in a position to propound as a general law *that the metals are more active physiologically according as their atomic weights are more elevated or*, which implies the same, *as their specific heat is lower;* but in applying this law, it is not to be supposed that a metal whose atomic weight is double that of another metal, is exactly twice as active as the latter, but only that it is somewhat more active. For example, in reference to sodium, potassium, and thallium: sodium, with an atomic weight of 23, is nearly inert; potassium, with an atomic weight of 39·1, is active in large doses; and thallium, with an atomic weight of 204, is a dangerous poison, nearly as poisonous, indeed as lead, whose atomic weight is 207. On comparing magnesium, zinc, and cadmium, it is seen that magnesium, with an atomic weight of 24, is scarcely more active than sodium, for the salts of the former are prescribed in about the same doses as the salts of the latter; while zinc, with an atomic weight of 65·2, is a dangerous substance, although much less so than cadmium, whose atomic weight is 112. Many other examples might be cited. The only exceptions that appear to exist to this *atomic or thermic law* are in the cases of rubidium, and of the tungstates and molybdates, which are not active when combined with inactive metals. It must, however, be remembered that the physiological action of those salts in which tungsten and molybdenum occupy the position of electro-positive elements, has not yet been examined. On the other hand, researches made subsequently to the discovery of this law have confirmed it. Thus lithium, with an atomic weight of 7, is a perfectly inert metal, and palladium, with an atomic weight of 106·6, is much less active than either gold or mercury, whose atomic weights are 197 and 200 respectively.

It is interesting to see how this law is applicable to the metalloids. Dr Rabuteau has found that the group of the *diatomic metalloids* conduct themselves in entire conformity to it. The *monatomic metalloids*, however, are governed by a law which is the reverse of this; as had been previously shewn by Bouchardat and

Stuart Cooper, who observed that chlorine (35·5) is more active than bromine (80), and the latter more so than iodine (127). Dr Rabuteau now demonstrates that flourine (19) conducts itself in accordance with this law, for the flourides are the most active among the compounds of the monatomic metalloids.—From another careful series of researches, Dr Rabuteau proves that the organism acts as a reducing agent, converting bromates into bromides, iodates into iodides, and sulphites and hyposulphites into sulphates.

DR GAMGEE'S REPORT.

Physiological Chemistry.

Blood.

On the Composition of the Gases which flow with the Blood through the Irritable Muscle of Mammalia, by C. Ludwig and A. Schmidt (*Arbeiten aus der Phys. Anstalt zu Leipzig*, 1869).

In the number of the *Journal of Anatomy* for Nov. 1868 (p. 230), a short abstract taken from the *Centralblatt* (1868, No. 32) was given of a paper by Professor Ludwig and A. Schmidt on the changes in the blood circulating through the muscles. The researches of the authors are now published *in extenso.*

On account of the great interest which now attaches to the questions treated of, as complete an abstract as is compatible with our space is given of this most admirable and ingenious memoir.

The authors commence by pointing out the various methods by which it has been sought to determine what relation exists between muscle and the gases, oxygen and carbonic acid. They discuss the objections which may be raised to the three methods which have been adopted. The first method consists in determining the total interchange of gases in the respiration of an animal which is alternately kept in a state of rest and subjected to muscular exertion. It is open to the objection that it does not enable us to differentiate between the influence of the processes going on within the muscles themselves, and those which take place in the vascular areas outside them. The second method consists in determining the changes which the blood undergoes in flowing through the muscles of a living animal during rest and during activity. Although the disturbing influence of other organs is here eliminated, the great and unavoidable variations in the blood current flowing through the muscles of a living animal give to the results only a qualitative value.

The third method consists in observing the deportment of the isolated muscle towards O and CO_2, and was employed by Du Bois Reymond, G. von Liebig, Valentin, Matteucci, and more lately by Hermann.

As objections may legitimately be raised to all these methods the authors determined to cause an artificial stream of defibrinated blood to flow through separated though still living muscles, and to investigate the change which the blood undergoes during the process.

The heart was the first muscle which the authors attempted to utilize for these experiments, but for various reasons they found it inapplicable to their purpose.

They then had recourse to the biceps and semitendinosus muscles of the dog, as they found that they could easily control the flow of blood through the vessels supplying these muscles. These two muscles are supplied with blood from a branch of the hypogastric artery and by three or four branches indirectly supplied by the femoral artery. The authors point out a peculiarity in the distribution of the arteries in the biceps which has hitherto escaped observation. When an arterial twig has entered amongst the bundles of muscular substance, it distributes itself to a perfectly definite portion of muscle, without communicating with neighbouring vessels. Blood or injecting fluid forced into the arterial twig flows into veins corresponding to it. It is only when an obstruction to the flow of blood through the vein exists that a current is developed in the other veins of the muscle, through the network of minute veins which surround the muscular bundles, as well as the fasciæ of the whole muscle, and establish a connection between the large venous trunks.

Two canulæ were tied into the arteries supplying the muscles; one being placed in the hypogastric, the other in the main branch from the femoral artery. All arterial twigs going to neighbouring parts were then diligently tied. Similarly two canulæ were introduced into the two principal veins coming from the muscles. The muscles were then separated from their attachments, a portion of the tuber ischii being sawn off with their origin.

The two arterial canulæ were connected with two limbs of a T shaped glass tube, the other limb being connected with the reservoir which contained the blood; similarly the two veins were connected with a second T tube communicating with a vessel into which the venous blood flowed, and where it might be collected for analysis.

The blood, used by the authors, was invariably that of the dog upon whose muscles they experimented; their usual proceeding consisted in bleeding the dog nearly to death, then after the blood had been defibrinated and otherwise prepared they killed the dog and proceeded with the preparation of the muscle. Sometimes they used arterialized blood, sometimes blood completely reduced by means of metallic iron (using small pieces of iron wire instead of iron filings as Rollet recommended); at other times they caused the blood of an asphyxiated animal to circulate, or the blood of asphyxia oxygenated.

The muscles experimented upon were placed in a glass vessel which was covered with a glass plate; the vessel was perforated so as to allow the tubes conveying arterial and venous blood to pass in and out of it, and to permit the passage of wires which connected the muscles with an induction coil which might be applied to tetanize

them; in some of their experiments they caused the muscles to communicate by a lever with a revolving cylinder, so that graphic representations of the amount of contraction were obtained. The blood was forced into the arteries by means of a mercurial column, which allowed the pressure to be varied at will. The authors observed that after passing an artificial current of blood for some time the pressure had to be considerably increased in order to keep up the original rate of flow. Thus, if with a biceps weighing from 15 to 200 grammes there was required at first a pressure of from 40—60 mm. of mercury in order to secure a flow of from 2·5 to 3·0 c.c. of blood per minute, after four hours a pressure of from 100 to 150 mm. would be required.

When a muscle through which an artificial stream of blood has been circulating is deprived of blood, the capability for doing work is not immediately lost. In the first stages of bloodlessness the irritability of the muscle increases, but soon sinks, at first with rapidity, then more slowly.

The circulation of blood freed from oxygen, or of the blood obtained from asphyxiated animals, exerts the same action on the irritability of muscles as the absence of blood.

Before discussing the results of their analyses of the gases of blood flowing through the muscles the authors discuss the possible influence of the difference between the air of the apparatus in which the muscles were placed and the blood contained in the vessels; it would appear that the error introduced from this source is very slight.

The authors examined in the first place the influence of the rate of the blood stream upon the amount of oxygen removed from the blood by the muscles.

They give the details of five experiments, shewing in each case the weight of muscle, the time in minutes from the commencement of the continual blood stream to the time of collecting the special sample of blood for analysis, the amount of O consumed per minute, the oxygen contained in the arterial blood, and that contained in the venous blood. The results shew conclusively that the quantity of oxygen taken up by muscle increases directly with the increase of the rate of flow. On referring to the table which shews the amount of oxygen in the blood returning from the veins, it will be found that it is greatest in those cases in which the largest consumption of oxygen by the muscle has taken place in the unit of time; the muscle appears, therefore, to separate oxygen from the blood with greatest ease when the latter contains O abundantly.

Whether supplied with an artificial stream of blood or not, muscle removed from the living body will ultimately die; when however oxygenated blood circulates through it its vitality is protracted for 17 or 20 hours longer than when it is deprived of blood, or furnished with blood which is not oxygenated. "Consequently, in opposition to doctrines hitherto held, a peculiar respiration goes on in muscle which proceeds independently of the so-called vital processes of the contractile structures" (p. 35).

The authors then proceed to consider the consumption of oxygen by the muscles under various conditions. They investigate, for instance, the influences of rest, muscular contraction and muscular fatigue, on the amount of O absorbed. They find usually the amount of O consumed by muscle in a state of activity perceptibly exceeds that consumed by it in a state of rest; this is also the case with muscle exhausted by work. From these experiments the authors cannot, however, assert that they have been enabled to determine any definite relation between the amount of O absorbed and the quantity of work done.

Before proceeding further to detail the results of these researches the authors shew how little fitted is the mere determination of the relative amounts of the gases absorbed and exhaled in respiration to teach us how much oxygen is required by muscles in a state of rest or activity. The considerable differences which have been found in the amount of O absorbed during rest and work have hitherto, without hesitation, been referred to processes going on in the contractile tissues. This inference is, however, shewn, by the researches of Ludwig and Schmidt, to be inadmissible. The more rapid flow of blood through muscles in a state of activity, may explain some of the increased absorption of O, independently of the act of contraction. But other causes are also at work. Muscular movements will tend for instance to empty many veins, and necessarily cause their contents to be added to the general mass of blood to be oxygenated in the lungs.

Although in these experiments the authors succeeded in imitating to a great extent the changes which go on in the blood in its circulation through muscles, they found that in the separated muscles the gaseous interchanges were not so great as in muscles connected with the body, the latter appearing to act more energetically upon the oxygen of the blood.

It would appear that even during rigor mortis mammalian muscle removes O from blood circulating through it.

Having determined that muscle which has been exhausted by work regains its irritability when subjected to a stream of arterialized blood, whilst it does not do so when treated with reduced blood, the authors proceeded to find what relation exists between the amount of O used up and the restoration of the muscle; these results are of startling interest. We quote two of their experiments. In the first experiment muscle was deprived of blood for 128 minutes; there was, as a result, complete loss of irritability. Reduced blood was then caused to circulate through the muscle for 38 minutes, but no restoration of irritability followed. During the three succeeding minutes 13·5 cub. cents of arterialized blood was passed through the muscle, with the result of restoring the irritability almost to the state in which it was before depriving the muscle of blood. In the 2nd experiment the irritability of a muscle was restored by the circulation of 7 c.c. of the blood of asphyxia which had been oxygenated. Careful experiments have led the authors to the astounding discovery that as little as 0·0018 grm. of O is sufficient to restore the irritability of a muscle weighing 209 grms. It would appear probable that the O absorbed

only affects the irritability, not acting on the group of arrangements whose resultant is the capability of doing muscular work. We must refer the reader to the original paper for the learned and ingenious commentaries which the authors append to the above remarkable facts, as well as for their remarks on the formation of carbonic acid in muscle.

On the Influence of the Addition of Combustible Molecules to the Circulating Blood upon the Respiratory Gas Exchanges. By Dr Schiremetjewski (*Ludwig's Arbeiten*, 1869, p. 114).

Two sets of views have been advanced to explain oxidation in the animal body. The first is that difficultly oxidizable molecules form, chiefly by decomposition in the tissues or blood, compounds which are easily oxidized by the oxygen present in the blood. This is supported by the discovery of Al. Schmidt, that in the oxygen-free blood of suffocated animals substances exist which are converted by the addition of O into CO_2 and H_2O. The second view, which has hitherto wanted facts for its support, is that some one of the constituents of living blood can give to O the properties of ozone. A probability at least would be given to this view if it were found that substances easily acted on by ozone were quickly oxidized, while others were not.

In order to determine this question, Schiremetjewski at Ludwig's suggestion undertook a series of experiments, in which he determined the amount of O consumed and CO_2 given out before and after injection of various substances, the increase in the O and CO_2 being taken as an index of increased combustion. The substances used were chiefly normal constituents of the animal body, viz., the soda salts of lactic, caproic, acetic, formic and benzoic acids; grape sugar and glycerine. The apparatus used was that invented by Ludwig, and described by Dr Sanders-Ezn in his paper on changes in respiratory exchange with variations in temperature (*Ludwig's Arbeiten* for 1867).

He confirms the statement of Sanders-Ezn and Lossen, that the number of respirations is no index to the activity of respiratory change. After injection of lactic acid he found that the amount of O used and CO_2 given off at once increased proportionally to the amount injected and still retaining the same ratio to one another, the quotient $\frac{CO_2}{O}$ remaining = 1.

The soda cannot have remained as carbonate in the system, otherwise the quotient would have been 0·84; and no alkalinity was detected in the urine. In order to determine that the respiratory increase was not due to increase in the absorption coefficient of the blood for O, or increased rapidity of the circulation, a stream of defibrinated blood mixed with lactate of soda was passed through a dog's kidney, and on comparing its gas content with that of a similar stream of pure blood, its O was found very considerably diminished and its CO_2 increased; the quotient $\frac{CO_2}{O}$ being = 1 in 3 out of 4 cases. He

concludes that were the number of experiments greater the combustion of lactic acid would be completely proved. Grape sugar caused no change in the respiration, and he thinks that sugar as such is not oxidized in the vessels. Blood, which stood with grape sugar in a flask at an ordinary temperature for 5½ hours, showed a loss of 3·25 per cent. of its O and a gain of 3·85 per cent. in CO_2, while another portion of pure blood remained unchanged. A very irregular result was obtained by passing blood mixed with grape sugar through a kidney; and probably the internal transformations which take place in this organ are too great, and another capillary district should be selected in future experiments.

The changes caused by caproate of soda were similar to those of lactate of soda; the quotient $\frac{CO_2}{O}$, however, being ·62 instead of 1. It is then probably burned in the blood. The experiments with acetate and formiate of soda gave no evident result; those with benzoate of soda a diminution of O and a very slight increase of CO_2, showing that it had neither undergone nor caused any decomposition. Glycerine gave an increase both of O and CO_2, indicating that it is probably quickly decomposed in the blood.

ALBUMINOID SUBSTANCES OF BLOOD.—Heynsius has published a paper on the Identity of Globulin (Paraglobulin) and Albuminate of Potassa, in *Pflüger's Archiv* (Zweiter Jahrgang, Erstes Heft, pp. 1—49).

He has arrived at the following results:—1. In blood-serum (particularly in that of the cow) diluted with ten times its volume of water, after the precipitate formed in it by CO_2 has been separated, another albuminous substance remains, which is precipitated on saturating the fluid with Na Cl. 2. Solutions of albuminate of potash, of fibrin, of myosin, exhibit the same phenomena. By CO_2 one part, by successive saturation with Na Cl another part, of the albumen is precipitated. 3. A smaller quantity of precipitate is obtained by Na Cl, than by CO_2 and Na Cl together. 4. The presence of a small quantity of phosphate of sodium does not prevent the precipitation of albuminate of potassium by CO_2. 5. The precipitate thrown down by CO_2 in all these substances is partially soluble in pure oxygen and hydrogen. But the paraglobulin of the blood is dissolved much more quickly and in much greater quantity by it. Besides the solubility in diluted solutions of salt is, in the case of paraglobulin, much greater. 6. This greater solubility is not, however, due to the paraglobulin itself, but to the salts mixed with it, or perhaps to other admixtures also. 7. If albuminate of potash be mixed with blood-serum free from paraglobulin, CO_2 produces a precipitate which is just as soluble as paraglobulin. 8. Also if fibrin, obtained from blood-clot, be heated for some time with such serum free from paraglobulin, carbonic acid causes a considerable and soluble precipitate in the diluted fluid, whilst the blood-serum itself, after heating, yields at most only an insignificant precipitate. 9. Except in the possession of fibrino-plastic properties, there is no difference between paraglobulin

and albuminate of potassium. 10. The albuminoid substance which is precipitated from diluted cow serum by saturation with Na Cl (after the removal of paraglobulin by CO_2), has no fibrino-plastic properties. 11. The fibrino-plastic property is probably due not to paraglobulin itself, but to another substance which is precipitated simultaneously by CO_2. 12. There is, then, no reason for establishing a difference between the substance precipitated by CO_2 and that precipitated by Na Cl. For both the author retains the name 'Globulin.'

ON THE AMOUNT OF GLOBULIN IN THE BLOOD-SERUM OF VARIOUS ANIMALS AND THE CAUSES OF THE DIFFERENCE THEREIN OBSERVED.—In a second investigation Professor Heynsius gives the result of further experiments on the amount of globulin in the blood of various animals (see this author's former paper on the same subject, *Journal of Anatomy and Phys.*, Nov. 1868, page 120). He confirms his first researches, which shewed that the blood of the cow is unusually rich in globulin.

In a third paper "On the origin of the Fibrin of the Blood" (*Pflüger's Archiv*), Professor Heynsius seeks to determine whether any of the constituents of the blood corpuscle contribute to the formation of fibrin. He sums up his conclusions as follows:—1. The quantity of fibrin that is obtained from the same blood by the same treatment, as a natural consequence of the defective methods of analysis, varies somewhat; the differences are not, however, as important as Mayer had thought. 2. By the whipping of blood, other things being equal, a higher amount of fibrin is found than by washing the clot. 3. Much greater differences than even Mayer had obtained are found if the blood before its coagulation be mixed with a certain quantity of phosphate of soda and shaken with it. 4. In the plasma of the dog the quantity of fibrin or of its parent substances is certainly smaller than the quantity of fibrino-genetic substance and globulin contained in the blood. 5. In chicken's blood the quantity of fibrin obtained is alone much greater than the quantity of fibrino-genetic substance that can be separated from the plasma diluted with a solution of salt of 4 per cent. 6. Doubtless therefore the albuminoid substance of the stroma (zooid) of the blood corpuscles contributes to the formation of fibrin.

The following papers may be referred to by those interested in the chemistry of the blood.

Contributions to the knowledge of the blood in man and mammalia by F. Hoppe-Seyler (*Med. Chem. Untersuchungen*, Drittes Heft, pp. 366—386).

Contributions to blood analysis by G. Jüdell (*Hoppe-Seyler's Untersuch.* 3 Hft, p. 386). On the composition of the blood corpuscles in Igel and of Coluber natrix, by F. Hoppe-Seyler (Op. cit. 391—394).

Salkowsky (*Hoppe-Seyler's Med. Chem. Untersuch.* 3 Heft, 436—437) in a little paper bearing on the question of the identity of hæmatoidin and bilirubin gives the results of his examination of

hæmatoidin derived from a cyst, which possessed all the characters of bilirubin.

Digestion.

Professor Hermann has published an Introductory Lecture entitled, A Contribution to our knowledge of digestion and nutrition (Zurich, 1869). The following is the substance of Dr Radziejewski's abstract (*Centralblatt* f. d. Med. Wissenschaft, 1869).

Digestion may be looked upon as a splitting up of the ingested nutriment and the assimilation of the products, which afterwards serve as materials for synthetical processes going on in the tissues. This process of splitting up, termed hydrolytic by the author, proceeds so that under the influence of ferments and with assimilation of water more simple bodies are produced. Thus, under the influence of ptyalin, starch is converted into grape sugar;

$$C_{12}H_{20}O_{10} + 2H_2O = 2\,(C_6H_{12}O_6).$$

Similarly, under the influence of ferments in the organism, uniting with the elements of water, salicin is converted into saligenin and glucose, fat into fatty acids and glycerine. By analogy albumen and gelatine peptones may be looked upon as derived by similar processes. This hydrolytic analysis can, as is well known, be imitated outside the organism by treatment with sulphuric acid. Kühne's discovery of leucin and tyrosin, among the products of the digestion of fibrin by pancreatic juice, furnishes an illustration of the process which goes on. From the comparatively simple bodies produced in the alimentary canal by this process of hydration the body can again build up the most differently constituted tissues. In the processes of this kind with which we are yet acquainted, as the production of hippuric acid from benzoic acid, of fat from soap (*Centralblatt*, 1868, p. 576), of glycogen from sugar, the synthesis only corresponds to the previous analysis, the building up of the more complex bodies from the more simple being accompanied by an elimination of water. Some of these transformations probably take place in the liver.

Gases of the Saliva.—Pflüger (*Archiv*, 1868, p. 690) has analyzed the gases of the submaxillary gland of the dog; he placed a canula into the duct of the gland and collected the saliva, which flowed on irritation of the lingual nerve, over mercury. After 35—40 c. c. had been collected, the tube was connected with the receiver of a gas pump containing a little water free from gas. The following are his results; 100 volumes of saliva gave in

	Exp. 1 (after unknown food).	Exp. 2 (after flesh diet).
O	0·4	0·6
CO_2 obtained without addition of acid	19·3	22·5
CO_2 expelled by addition of phosphoric acid	29·9	42·2
Total CO_2	49·2	64·7
N	0·7	0·8

On the source of free hydrochloric acid in the gastric juice by Professor E. N. Horsford, Cambridge, U.S.A. (*Proc. R. S.* no. 111, p. 391).

The author believes that "whatever other peculiarities the blood corpuscles may possess, they have the requisites for furnishing acid phosphates in solution under pressure, such as may attend engorgement of the capillaries in the walls of the stomach." He shews that by the reaction of acid phosphates on alkaline chlorides free hydrochloric acid is obtained, and this process he supposes to occur in the stomach.

"Let us glance," says the author, "at what takes place in all probability as the acid fluid enters the gastric tubules. They are surrounded by a mixture of hydrochloric acid, acid salts, neutral salts and albuminoid bodies. Dialysis must be repeated, and a stronger acid solution pass into the sacs or cells contained in them.

"The sacs swelling by endosmosis, and corroded by the acid, must at length burst, and the liquid contents, together with the disintegrated and partially digested membrane of the sacs, pass out into the stomach, to constitute the gastric juice, the free hydrochloric acid, and phosphates and chlorides, and the albuminoid bodies and disintegrated tissue (pepsine?) to act in the liquefaction of food."

Absorption from the large intestine.—An abstract of a paper on this subject by C. Voit will be found in the *Centralblatt* (1869, No. 24).

Bile.

The following papers on bile pigments may be referred to:—

1. Bogomoloff on a new reaction for the detection of bile acids (*Centralblatt,* 1869, No. 31).

2. Bogomoloff on the characters of the spectrum of bile in Gmelin's reaction and in Pettenkofer's reaction (*Centralblatt* 1869, No. 34).

On the general questions connected with the secretion of bile and the influence of food, weight of body, and other circumstances upon it, consult the Report of the Edinburgh Committee on the Action of Mercury on the Biliary Secretion (*Report of the* 38*th Meeting of the British Association* for 1868, p. 187—232).

Schmulewitsch (*Centrablatt,* 1869, No. 34), has made some experiments on the secretion of bile, under Ludwig's direction.

The secretion of bile in the liver of a newly killed rabbit may be kept up for some time by passing a stream of defibrinated dog's blood, diluted with a weak solution of Na Cl, through it.

Pflüger has investigated the gases of the bile of the dog (On the gases of the secretions, *Pflüger's Archiv,* 11, p. 156—178). The secretion contained in one case no O, in the other only a trace. The amount of CO_2 varied immensely in the two experiments recorded, being very high in alkaline bile and very low in neutral bile.

Milk.

The reader may refer to a paper by Stohmann, on the consumption and excretion of nitrogen in milch goats (*Centralblatt*, 1869, No. 21). Pflüger has analysed the gases of milk (*Archiv*, II. p. 156—178). The following numbers shew the amount of the different gases obtained from 100 volumes of milk.

	1st Experiment.	2nd Experiment.
O	0·10	0·9
CO_2	7·60	7·40
CO_2 expelled by phosphoric acid	0·00	0·20
N	0·70	0·80

Urine.

In his investigation on the gases of the secretions Pflüger (*Op. cit.*) has examined the composition of the gases of the urine. The following numbers represent the amount of gas given out by 100 volumes of urine in two experiments:

	1.	2.
O	0·07	0·08
CO_2	14·30	13·60
CO_2 expelled by phosphoric acid	0·70	0·15
N	0·88	0·92

Estimation of Uric Acid in Urine.—The Rev. W. V. Harcourt has published the results of some experiments made on himself with a view to determine the solvent powers of solution of carbonate and citrate of potash on uric acid calculi. His paper contains some important details on the estimation of uric acid (See *Medical Times and Gazette*, October 1869).

The following papers referring to the chemistry and pathology of the urine may be consulted.——Gaehtgens.—On the excretion of creatinin and uric acid in diabetes (*Hoppe-Seyler's Med. Chem. Untersuch.* 3 Heft, p. 301—318).——Riesell.—On the influence of the injection of carbonate of calcium upon the excretion of phosphoric acid in the urine.——Schultzen.—On the quantitative determination of oxalate of lime in urine (*Centralblatt*, 1869, No. 17).——Struve.—On the quantitative determination of Iodine in different fluids and especially in urine (*Journ. f. Prakt. Chem.* 1868, CV. 424—433).——Huppert and Riesell.—On the excretion of nitrogen in fever (*Arch. d. Heilk.* 1869, p. 329—334, *Centralblatt*, 1869, No. 22).——Dr. Arthur Leared.—On the presence of sulphocyanides in the blood and urine (*Proc.* 1869, No. 114. Read June 17th).

Professor Rutherford's Report.

Nervous System.

Cerebrum.—Contributions to the Study of the Functions of the Brain of the Frog. By Prof. Goltz of Königsberg (*Centralblatt*, 1868, p. 690 and p. 705). On the Movements which take place after Removal of the Cerebral Hemispheres. By Prof. Rosenthal (*Centralblatt*, 1868, p. 739). Concerning a Pigeon from which the Cerebral Hemispheres had been removed in July, 1861. By Prof. Voit (*Münch. Akad. Bericht*, 1863, *Centralblatt*, 1864, p. 53). Observations on Removal of the Cerebral Hemispheres in the Pigeon. By Prof. Voit (*Münch. Akad. Bericht*, 1868, pp. 105—108. *Centralblatt*, 1868, p. 752).

The following is a translation of a valuable report on the above Memoirs by Professor Vulpian (*Archives de Physiologie*, 1869, p. 301).

After removal of the cerebral hemispheres from frogs and pigeons, these authors observed results which are in great part already known, viz. persistence of the co-ordinated muscular movements necessary for maintaining the normal attitude and locomotion: power of walking or flying: preservation of certain apparently instinctive movements, such as placing the head under the wing, etc. All these phenomena were previously observed by Flourens, and his results have been confirmed by all who have repeated his experiments. Moreover, Longet observed that in animals deprived of the cerebrum, visual and auditory impressions can still be produced, and this fact has likewise been confirmed by the majority of experimenters.

The only point regarding which physiologists are at variance, is whether or not animals so treated are absolutely deprived of intelligence. Flourens, from numerous experiments, concluded that intelligence is completely abolished in animals from which the cerebral hemispheres have been removed. This interpretation has been adopted by Longet, and by the greater number of Physiologists who have studied this question by observations of their own. It is the opinion maintained by Prof. Vulpian also, in his *Leçons sur la Physiologie Générale et Comparée du système nerveux.*

In the first Memoir by Voit above mentioned, after a description has been given of the chief phenomena presented by a pigeon from which the cerebral hemispheres had been removed, the following lines occur. "It follows from these observations that the pigeon retained all kinds of sensation, but the sensations failed to call forth any idea. The cerebral hemispheres are therefore the sole organs of ideas, conception, judgment, and probably also of volition; on the other hand all the purely organic operations and the perception of impressions do not appear to depend on these parts of the encephalon." Goltz differs from Voit in his conclusions, the former believing that all intelligence is not removed with the cerebrum in

such a case. His experiments were made on frogs, and he rests his opinion on some observations which according to Vulpian are capable of quite another interpretation. Goltz remarks that frogs not only preserve the power of seeing, but when compelled to move, they, on account of visual impressions, avoid obstacles placed in their way.

Vulpian (*Op. cit.* p. 669 and p. 674) had already indicated facts of the same sort in his experiments on fishes, but he, far from concluding from these that intelligence persists in such conditions, endeavoured to show by them that the domain of automatic actions is much more extended than is generally admitted.

As for the other argument advanced by Goltz, viz. that which he draws from his observations of the movements tending to maintain and especially to regain the equilibrium of the animal, its value may in like manner be seriously disputed. Goltz placed a frog which he had operated upon, on a board. He afterwards gradually raised its edge, and the animal which was being notably inclined endeavoured to clamber up towards the high edge of the board. Vulpian only sees in this a manifestation, very remarkable it is true, of a strong tendency to maintain the normal attitude which may be observed in all animals, and which is very marked in the case of the frog. Rosenthal has notified the existence of similar phenomena in the case of the pigeon from which the cerebral hemispheres had been removed. Whenever the pigeon walked to the side of the table and one of its feet went over the edge, it flapped its wings until it recovered its footing. This fact Vulpian deems of less value as evidence of the preservation of the intellectual faculties in such a case than a similar fact mentioned by Flourens, viz. that birds in such a condition fly when they are thrown into the air, and another fact observed by Vulpian (*Op. cit.* p. 681), that decerebrated frogs when they are thrown into a basin of water, swim towards its side, seize the edge of the vessel and cling to it until they are taken out of the water.

The most interesting fact amongst those which these authors have published, is undoubtedly that observed by Voit (*Centralblatt*, p. 752). A pigeon from which he had removed the cerebrum withdrew itself or flew away whenever one attempted to seize it: but it never ate anything. It was killed five months after the operation. "In the place of the cerebrum which had been removed, there was found a white mass continuous without interruption or line of demarcation with the peduncles of the cerebrum which had not been taken away. It had the form of two hemispheres, each of which contained a little cavity filled with fluid. The entire mass consisted of nerve tubes with perfect double contours, intermingled with nerve cells. Here is the first instance, adds Rosenthal, in his abstract of Voit's memoir, of reproduction of the cerebrum with restoration of its functions." But, adds Vulpian, of what value is it? One would be strongly inclined to doubt it even if one did not know that many physiologists have kept pigeons operated on in this manner, and have not observed anything of the kind. Voit himself kept a pigeon twenty-two months after the operation (*Centralblatt*, 1864), and ob-

served no tendency whatever to reproduction of the cerebrum. In frogs and in the triton nothing has ever been observed which would lead one seriously to believe in such a reproduction. One cannot of course refuse *a priori* to believe in the possibility of such a regeneration, seeing that the caudal portion of the spinal cord may be reproduced in reptiles; but a demonstration of the fact is necessary, and it appears to Vulpian that Voit's observation is very far from furnishing it. There is nothing to prove that in his experiment the cerebrum had been completely removed. Vulpian has frequently seen in both fowls and pigeons, a portion of the cerebrum left behind after the most accomplished experimenters thought they had completely removed it, and it is very probable that Voit's experiment should be classed with these.

If the complete removal of the cerebrum is indispensable ere we can come to a definite conclusion regarding the possibility of its reproduction, it is none the less necessary ere we can rightly apprehend the extent to which the encephalic functions suffer in animals thus operated on. Vulpian has elsewhere (*Op. cit.* p. 709) insisted on this important point in experimental physiology. He there mentions an experiment which he made on a frog. After having as he thought removed the entire cerebrum, he observed that, contrary to what had happened in similar cases, it pursued and snapped up insects which he placed in the glass vase where it was confined. When he examined the encephalon, about six weeks after the operation, he observed that the posterior part of the cerebrum had not been taken away.

In conclusion, the experiments detailed by Voit, Goltz, and Rosenthal, although they show some interesting facts regarding the results of removal of the cerebral hemispheres, do not add much to our knowledge of these nerve centres, and as for the fact mentioned by Voit regarding the reproduction of the cerebrum in the pigeon, it should be regarded as extremely doubtful, inasmuch as it has not been confirmed by further research[1].

CORPORA QUADRIGEMINA.—Dr Philipp Knoll (Beiträge zur Physiologie der Vierhügel. *Eckhard's Beiträge,* 1869, p. 111—136) gives the following as the results of his experiments on rabbits. "1. There is no sympathetic contraction[2] of the pupil in rabbits. 2. There is no tonic contraction of the sphincter pupillae produced through the motor oculi independent of the optic nerve. 3. In the rabbit the fibres of the optic nerve which govern the reflex contraction of the pupil decussate in the chiasma without any exchange of fibres. 4. Section of the optic nerve behind the chiasma produces loss of the reflex contraction of the pupil of the opposite eye. 5. Laceration of the corpora quadrigemina and optic thalami, the optic nerves being apparently uninjured do not produce any change

[1] In connection with this subject I would refer the reader to a very instructive note by Professor Morris in this Journal. 1st series, 1867, p. 222.—W. R.

[2] That is—the contraction of the pupil of one eye produced by throwing light on the retina of the other.

in, and contraction of the pupil, on the application of light. 6. The dilatation of the pupil of the opposite eye with loss of its contraction on the application of light, which previous experimenters had observed result from extirpation or section of one of the corpora quadrigemina, was probably due to injury inflicted also upon the optic nerve. 7. Any decided influence of the optic thalami and corpora quadrigemina upon the general mobility of the body is not recognisable. 8. Irritation of one of the anterior corpora quadrigemina by means of weak induced electrical currents dilated the pupils of both eyes, but especially that of the eye of the corresponding side. 9. This dilatation depends on irritation of the fibres derived from the cervical sympathetic which pass through the corpora quadrigemina. 10. There is in all probability a partial decussation of these fibres in the corpora quadrigemina."

OLFACTORY NERVES.—From experiments on dogs carried on under Bernard's direction, Gianuzzi came to the conclusion that section of the olfactory nerves does not quite abolish the sense of smell. J. L. Prevost (Note relative aux Fonctions des Nerfs de la première paire. *Sep.-Abdr. aus Arch. des Sciences*, 1869, p. 22. *Centralblatt*, 1869, p. 478) repeated his experiments, adopting his method of experimenting. He opened the cavity of the cranium through the inner wall of the orbit, and divided the olfactory nerves upon the cribriform plate of the Ethmoid by means of a knife similar to that employed for dividing the Trigeminus. When the section was completely successful the sense of smell was entirely lost. He employed the usual excitants of the olfactory nerves, morsels of flesh wrapped up in paper, etc.

CHORDA TYMPANI.—Lussana (Recherches expérimentales et Observations Pathologiques sur les nerfs du gout. *Archives de Physiologie*, 1869, p. 197) says that the gustatory filaments of the lingual nerve are entirely derived from the Chorda Tympani. Vulpian (*Op. cit.* p. 209) in a note at the end of Lussana's paper, says that that gentleman's researches ought to be interpreted in quite another way, and that he (Vulpian) has by his experiments proved that "1. the fibres of the Chorda Tympani are in connection with the submaxillary gland; 2. that the nerve furnishes no branch to the tongue, and cannot in any sense be considered a nerve of taste."

VAGUS AND BLADDER.—Oehl (*Gaz. Lombard.* 1868, Nos. 10 and 12) finds that if the central end of the divided vagus be excited the wall of the urinary bladder contracts. There seems therefore to be a reflex nervous connection existing between them.

VAGUS AND SPLEEN.—According to the same observer (*Op. cit.* 1868, Nos. 9 and 10) if the spleen be watched while the lower end of the divided vagus is being stimulated in dogs, rabbits, and cats, its surface becomes granulated. He ascribes this to contraction of muscular fibres in the splenic trabeculæ and vessels.

Vascular System.

Heart.—Cause of First Sound. Dogiel and Ludwig (see *Jl. of Anat. and Physiology*, II. No. III. p. 207) said that the first sound of the heart is chiefly a muscular sound. P. Guttmann (*Virchow's Arch.* XLVI. p. 223) declares against this opinion. He repeated the experiment of the above-mentioned observers, and ascertained that in the bloodless heart the systolic sound has a character quite different from that produced in the heart when the blood is flowing through it (see my report of Dogiel and Ludwig's experiments, *l. c.*) and causing closure of the valves. Guttmann says that the tension of the auriculo-ventricular valves is not got rid of even in the bloodless heart when it contracts, inasmuch as the papillary muscles continue to contract and tighten them.

Respiratory System.

Vagus, Nasal Nerve and Respiration.—Professor Paul Bert (*Archives de Physiologie*, II. pp. 179 and 322) gives an account of researches on "The Effect of stimulation of the Vagus, Superior Laryngeal and Nasal Nerves upon Respiration." His paper is copiously illustrated by tracings of the respiratory movements. In concluding his memoir he gives the following propositions. "1. Respiration may be arrested by stimulation of the vagi (Traube), of the larynx (Bernard), of the nares (Schiff), of most sensory nerves (Schiff). Bert has not however been able to confirm the latter statement. 2. This arrest may take place either in inspiration or in expiration by irritation of any of these nerves, without its being possible to ascribe the result to stimulation of any other nerves by the electrical current used as the stimulus. 3. Slight stimulation quickens, a more powerful stimulus slows,—while very strong irritation arrests—respiration. In opposition to Rosenthal, Bert believes that section of the vagi does not increase the difficulty of arresting the respiration: indeed death is more easily produced by arresting the respiration in such cases. 4. When the respiratory movements are completely arrested, the same is always observed with regard to the general movements of the animal, which remains motionless. 5. Respiration may be resumed even during the continuation of the irritation of the nerve, and when this is discontinued the movements are almost always accelerated. 6. Arrest is much more easily obtained during expiration than during inspiration; in some animals it is even impossible to obtain the latter. 7. If a sufficiently powerful stimulus be used to stop the respiration during the period of inspiration, one may cause the respiratory movements to cease the instant the excitant is applied (in inspiration, semi-inspiration or expiration), whether it be to the vagus or the superior laryngeal nerve."

Digestive System.

Intestine.—Experimental Researches on the movements of the Intestine by Legros and Onimus (*Journal de l'Anatomie*, 1869,

p. 163). On the Absorption of Albuminous Substances in the Large Intestine, by J. Bauer (*Sitz. Berichte der König. Bayer. Akad.* 1868, Bd. II. p. 511). See excellent abstracts of these memoirs by Mr Power (*Brit. and For. Med.-Chir. Review*, 1869, p. 245).

GLANDS.

LIVER.—SECRETION OF BILE.—In the Report of the Edinburgh Committee on the action of Mercury, Podophylline, and Taraxacum on the Biliary Secretion (*British Association Reports* for 1868. *British Medical Journal*, May 8, 1869), are several very important physiological facts regarding the secretion of bile in the dog. Numerous very accurate observations made by the committee show that the relation between the biliary secretion and the amount of food consumed is by no means so close as Bidder, Schmidt, Arnold, and others have supposed. In dogs, previous to the administration of drugs, it was frequently seen that while the animal ate the same food daily the secretion of bile underwent great variation. The amount secreted during the day was sometimes only a half, and even less, than it was on previous and subsequent days. And on the other hand it was frequently noticed that although the amount of food taken varied greatly, the secretion of bile was remarkably constant. In some dogs however the secretion was greatly influenced by the amount of food. Neither was the close relation supposed to exist between the amount of the biliary secretion and the size or weight of the animal supported by the observations of the Committee. The amount of bile secreted per kilogramme of dog varied greatly in different cases as the following table shows.

"Table XXI. Average Amount of Bile secreted per kilogramme weight of the dogs observed by the Committee before drugs were administered.

No. of Dog.		Fluid Bile.	Bile Solids.
		grammes.	grammes.
Dog 1	First experiment.	6·47	0·412
,, ,,	Second experiment.	7·82	0·28
,, 2		5·27	0·34
,, 3		5·76	0·293
,, 4		3·53	0·146
,, 5		21· 8	0·801
,, 6		20·66	0·818
,, 7		4·64	0·23
,, 8		9·24	0·305
,, 9		10· 2	0·58

This table suffices to show how fallacious must be the calculations which have been made by Bidder and Schmidt regarding the human biliary secretion from observations on dogs, and observations too which certainly were not nearly so accurate as those made by the Committee, inasmuch as Bidder and Schmidt collected the bile for a few minutes at a time and made their calculations from results obtained in that most unsatisfactory manner, while the results contained in the above Table are taken from a very large number of observations of the quantity of bile secreted daily. By means of an apparatus described in the Report, they collected the bile most satisfactorily for successive periods of twenty-four hours.

Although the dogs generally became emaciated from loss of bile, the Committee observed that very strong dogs bore the loss with apparent impunity.

It was observed that muscular movement exercises a marked influence upon the *flow* of bile. When the dogs were taken out of their cages—in which their movements had been a good deal circumscribed, and allowed to run about—it was frequently noticed that during the first half hour or so of their increased movement, the amount of bile discharged by the fistula was greatly increased. This was in all probability due to the bile being more rapidly expelled from the hepatic ducts by the pressure upon the liver of the contracting abdominal muscles, which must when in action compress the liver like a sponge, and so expel its contained fluid. This fact is valuable in serving to show that exercise may have an important influence upon the removal of bile from the liver. It further points out, however, how utterly fallacious must the results have been had the Committee endeavoured to estimate the daily secretion of bile from collections made during a few minutes at a time, such as were made by Bidder and Schmidt.

It was always observed that purgation, whether due to Pil. Hydrargyri, Calomel, Corrosive Sublimate, Podophylline, or spontaneous as in diarrhœa or dysentery, was always accompanied by a marked *diminution* in the *secretion* of bile.

The experiments were all made on dogs. In the report, the mode of establishing biliary fistulæ and of collecting the bile has been carefully described for the use of future experimenters, because of the marked success which attended the employment of the methods adopted by the Committee. The fistulæ were made by opening the fundus of the gall bladder and tying the common bile duct. The members of the Committee were Professor J. H. Bennett, *Chairman*, Professor Christison, Professor Maclagan, Dr Rogers, Dr Thomas R. Fraser, Dr Arthur Gamgee, and Dr William Rutherford. All the experiments were performed and the observations recorded by Dr Gamgee and myself.

INNERVATION OF LIVER.—Pflüger (*Archiv für Physiologie*, II. p. 190) in a preliminary communication states that he has come to the conclusion that nerves terminate in the hepatic cells just as they do in the secreting cells of the submaxillary gland and pancreas.

He believes that there is a centre for the innervation of the liver within that organ itself, because the secretion of bile continued almost unchanged after division of the nervi vagi, phrenici, splanchnici, and destruction of the nerves entering the porta hepatis. Stimulation of these nerves produced no decided result upon the biliary secretion. Powerful stimulation of the liver itself by means of electricity often suddenly arrested or diminished the secretion for a considerable time.

SECRETION OF GLYCOGEN.—Professor Austin Flint thus sums up experiments undertaken for the purpose of reconciling some of the discordant observations upon the glycogenic function of the liver (*New York Med. Jl.*, Jan. 1869). Dr Flint says that, "Although these experiments are not entirely new, my interpretation of them serves to harmonise, in my own mind at least, the results obtained by Bernard and Pavy." His conclusions are, "1. A substance exists in the healthy liver, which is capable of being converted into sugar; and inasmuch as this is formed into sugar during life, the sugar being washed away by the blood passing through the liver, it is perfectly proper to call it glycogenic, or sugar-forming matter. 2. The liver has a glycogenic function, which consists in the constant formation of sugar out of the glycogenic matter, this sugar being carried away by the blood of the hepatic veins, which always contains a certain proportion of sugar, and subserving some purpose in the economy connected with nutrition as yet imperfectly understood. The production of sugar takes place in the carnivora as well as in those animals that take sugar and starch in their food; and is essentially independent of the kind of food taken. 3. During life, the liver contains only the glycogenic matter, and no sugar, because the great mass of blood which is constantly passing through this organ washes out the sugar as fast as it is formed; but after death, or when the circulation is interfered with, the transformation of glycogenic matter into sugar goes on; the sugar is not removed under these conditions, and can be detected in the substance of the liver."

GENITO-URINARY SYSTEM.

HYDRURIA.—Eckhard, in his *Beiträge* (1869, 4ter Band, 3tes Heft, pp. 153—193), communicates the results of a most difficult and elaborate research on the nerves which produce hydruria (polyuria) when the floor of the 4th ventricle is punctured. In opposition to Bernard's statement that puncture of a certain spot in the floor of the 4th ventricle always produces hydruria, Eckhard says (p. 163), I know of no such point in the floor of the 4th ventricle of the rabbit. The hydruria does not always follow puncture of the same spot and sometimes it follows puncture of various parts of the floor. Eckhard confirms Bernard's observation that section of the splanchnicus major produces hydruria, but though Eckhard finds this true in the case of the dog, he finds that in the rabbit the section has no effect upon the urinary secretion. Irritation of the renal end of the

divided nerve diminishes the secretion in the dog, but has no effect in the rabbit. Eckhard, moreover, failed to observe any result follow section of the other renal nerves in the rabbit. In his opinion the hydruria following section of the splanchnicus major and that resulting from puncture of the 4th ventricle cannot be ascribed to injury of the same nerves; because, while in the rabbit, section of the splanchnic fails to induce hydruria, puncture of the 4th ventricle does so easily; moreover when the splanchnicus major of one side is divided and the 4th ventricle afterwards punctured, the secretion of both kidneys is increased. The following is an example of numerous experiments regarding this point. Canulæ were introduced into both ureters of a dog, and the *left* splanchnicus major afterwards divided. During the four following hours the urine was measured at the end of every hour. And it was found that there had flowed from the

	1st hr.,	2nd hr.,	3rd hr.,	4th hr.	
Right ureter	0·6;	1·0;	1·2;	1·6	cubic centimètres
Left „	2·5;	2·0;	2·1;	2·4	„ „

The membrana obturatoria atlantis was then laid bare, and after this operation the urine was again collected for two hours.

Right = 1·5; 1·5,
Left = 2·4; 2·1.

The floor of the 4th ventricle was then punctured on the left side of the middle line, and the following hourly measurements obtained.

Right = 4·9; 2·7; 1·9,
Left = 9·6; 4·7; 3·5.

Eckhard here remarks that the urine resulting from the puncture "was as a rule much clearer than that which followed the simple section of the splanchnicus major." Experiments like the above convinced him that when the 4th ventricle is punctured the nerves which convey the influence to produce the hydruria are not contained in the splanchnicus major. With a view to ascertain the course of these nerves, he next divided in the dog all the nerves uniting the trunk of the sympathetic to the left kidney, and then punctured the left side of the floor of the 4th ventricle as before. As before Hydruria resulted from *both* kidneys. He therefore concluded that these nerves are not the channel through which the influence passes from the 4th ventricle to the kidney. In like manner he excluded the phrenic and pneumogastric nerves, the branch which connects the first dorsal ganglion with the vago-sympathetic nerve in the dog, and the branches from the hypogastric plexus. Eckhard has not yet come to a decision regarding the nerves implicated, and is still engaged in prosecuting the enquiry.

Miscellanea.

Pigment Cells of Frog.—See an abstract of a paper by Hering and Hoyer, On the Movements of the Stellate Pigment Cells of the

Skin of the Frog (*Centralblatt*, 1869, p. 49), by Mr Power (*Brit. and For. Med.-Chir. Review*, No. LVIII. p. 248).

TEMPERATURE OF CHILDREN.—From numerous observations Dr Finlayson of Manchester (*Glasgow Med. Jl.* Feb. 1869) concludes that, 1. The daily range of temperature is greater in the healthy child than that recorded in healthy adults. Finlayson finds a daily variation of from 2—3° F. 2. There is invariably a fall of temperature in the evening amounting to 1, 2 or 3°. 3. The most striking fall usually occurs between 7 and 9 o'clock P.M., although it often begins about 5 P.M., and frequently continues until after midnight. 4. The minimum temperature seems usually to be reached at or before 2 A.M. 5. The temperature usually begins to rise between 2 and 4 A.M. 6. Fluctuations between 9 A.M. and 5 P.M. are usually trifling. 7. There seems to be no very definite, or at least obvious relation between the frequency of the pulse and respirations and the amount of normal temperature.

NOTICES OF RECENT DUTCH AND SCANDINAVIAN CONTRIBUTIONS TO ANATOMICAL AND PHYSIOLOGICAL SCIENCE. BY W. D. MOORE, M.D., Dub. et Cantab., M.R.I.A., &c., &c.

1. THE *Nederlandsch Archief voor Genees en Natuurkunde*, IV. 5, 1869, contains an important paper by Dr Th. W. Engelmann, upon the *periodical development of gas in the protoplasm of living Arcellæ.*

The author having had his attention attracted to the occurrence of air bubbles in the protoplasm of Arcella vulgaris, has been able to establish some phenomena, which appear to be in more than one respect worth recording.

If we bring a drop of water, containing living specimens of Arcella, into contact with the under surface of the covering glass of the gaschamber, we find immediately afterwards, on microscopical examination, most of the Arcellæ beneath in the drop. On each of these we distinguish the well-known brown, concavo-convex, reticulately striated shell, whose cavity is in great part filled with protoplasm. This projects at the same time slightly through the annular opening found in the centre of the concave side of the shell. It contains granules of various sizes, nutritious matters, vacuolæ, a number of contractile spaces close to the periphery of the protoplasm situated within the shell, lastly six, eight, or more clear nuclei, each with a very large round nuclear corpuscle. The animalculæ either lie on the back, or turn the opening of their shell downwards. In the latter case the Arcellæ can attach themselves by their protoplasm-outrunners to the under surface of the drop and so

move. Often however, in fact always when they lie on their back and the opening of the shell is thus turned upwards, the following is observed.

After the animalculæ have lain quietly for a time (from two minutes to about quarter of an hour) or have in vain endeavoured with their pseudopodia to reach a fixed point, several (usually from 2 to 5, sometimes as many as 14) dark points appear, simultaneously or shortly after one another, in the protoplasm. These lie nearly always at a short distance from the periphery of the protoplasm contained in the shell, and often at very regular distances from each other. Even after a few minutes we observe that the dark points become larger and swell up into distinct blackly circumscribed air vesicles usually of an irregularly spheroidal shape. Soon the volume of the air vesicles has so much increased, that they occupy a considerable portion of the space in the shell. Thereby a part of the protoplasm, which is otherwise contained in the shell, is of course pushed out. If only few air-bubbles be present, these all attain a considerable magnitude (up to 0·06 mm. in circumference); if there be many, the separate vesicles are smaller (about 0·01—0·02 mm.). They remain constantly surrounded on all sides by protoplasm. If they have attained nearly their maximal size, which is the case usually in from 5 to 20 minutes after the first appearance of the air-bubbles, the Arcella begins all at once to rise and ascend slowly, often with progressive rapidity, perpendicularly in the drop, until it reaches the upper surface. There it can, if the opening of the shell continues turned upwards, usually attach itself by means of its protoplasm-podia and move about. If this takes place, the air-bubbles rapidly become smaller, after from 5 to 10 minutes they are generally reduced to vesicles of scarcely 0·002 mm. in diameter and now disappear, often quickly after one another, with a sudden chuck. But if the Arcella come to lie with the back upwards, the volume of the air-vesicles does not diminish, so long as the animalcule does not succeed in turning round and attaching itself above. But so soon as the Arcella, which has lost its air, is again loosened, by shaking the drop, or by carefully touching the animalcule with a fine needle, it sinks directly down into the drop. After some time, often after only a few minutes, air-bubbles are again developed in the protoplasm, by means of which the Arcella rapidly rises again to the surface of the drop. If it succeed in attaching itself there, we can, so soon as the air-vesicles have again disappeared, or have at least become much smaller, repeat the experiment.

If the Arcella lies beneath in the drop on its back, it sometimes happens that only on one side a single or few air-bubbles are developed. After some time the animalcule begins to rise on this side and comes to stand on its sharp edge. In this position it usually succeeds in reaching a fixed point on the under surface of the drop, and in then so turning further round, that the abdominal surface comes to lie downwards. So soon as this takes place, the air-bubbles become smaller and disappear almost completely in the following few minutes.

An analogous phenomenon is sometimes observed in Arcellæ which, when the back is turned upwards, float by means of their air-bubbles on the upper surface of the drop. After they have for a time made many fruitless efforts to attach themselves somewhere by their outrunners, the air-bubbles become on one side smaller. Consequently this side sinks downwards, the Arcella assumes an oblique and then a vertical position, and finally turns completely round, so soon as an outrunner has found a fixed point. The air-bubbles then rapidly disappear.

In general the air-bubbles are developed and increase only when the Arcella cannot attach itself and move by means of its pseudopodia. From the moment when the protoplasm-podia have found a fixed point, the gas-bubbles usually become smaller. We can by attending to this, with almost perfect certainty foretell whether an Arcella will develop air or not, and if air-bubbles be already present, whether these will increase or diminish. By bringing the animalculæ artificially (for example by means of a needle under the simple microscope) into different positions, we can at pleasure make the air-bubbles appear or disappear, increase or diminish.

In fresh specimens these experiments always succeed. But if the animalculæ have already for some time been used in experimenting, and have repeatedly formed and again absorbed air-bubbles, their power of developing gas evidently diminishes. If we then, for example, place an Arcella on its back underneath in the drop, air-bubbles do indeed form, but they appear comparatively late, in smaller number than in the first experiments, increase slowly, and do not become large enough to enable the animalcule to rise. The air-bubbles in that case usually continue for a quarter of an hour or longer tolerably large, periodically diminish and increase a little, finally they gradually disappear and do not form again. If an Arcella has by means of its gas-vesicles floated for a very long time on the surface of the drop, without being able with its outrunners to seize on a fixed point, it not unusually happens that the air-bubbles by degrees become smaller and the animalcule at last sinks. The Arcellæ are therefore *fatigued* by long continued development of air. This fatigue often exhibits itself only in the diminution of the power of developing gas; the movements of the protoplasm-podia and those of the contractile spaces may be as active as in the commencement and may last a long time. But in other cases the protoplasm movements also diminish in rapidity, the protuberances become retracted, short and broad, and scarcely project above the edge of the central annular opening of the shell. If we then allow the animalculæ to rest for some time (half an hour or longer), the movements begin anew, and the power of developing air also is more or less completely restored.

The air-bubbles seem to be capable of development in all parts of the protoplasm within the shell. But we never find them in the nongranular protoplasm of the pseudopodia. If they had disappeared, they often arise with fresh development of air in totally different places, and even while they exist, their position changes, although

very slowly. No connexion was demonstrable between the situation of the air-bubbles and that of the contractile vacuolæ or of the nuclei.

The protoplasm surrounding the air-vesicles does not present any perceptible optical difference from the rest. Neither on the appearance, nor on the disappearance of the air-bubbles, are changes observable in it, except, of course, the slight displacements connected with the modifications in the form and the volume of the gas-vesicles.

It is important that the form of the air-vesicles is scarcely ever perfectly spheroidal, but almost always irregular, for example, ellipsoidal, pyriform, or even polygonal. It is at the same time very changeable. In general the gas-bubbles when forming, and so long as they are still increasing, have comparatively the most regular form: they are nearly spheroidal or, if they are very large, by accommodation to the shape of the shell, reniform. During absorption however the form becomes almost every moment a little modified, and continues rather irregular until its total disappearance. Instead of being biconvex, as in the process of distension, the gas-bubbles are, for example, biconcave, &c. From these facts we may infer, what indeed the granular movement in the protoplasm shows, that the state of aggregation of the protoplasm surrounding the gas-vesicles of the living Arcellæ is not that of a fluid. For the pressure exercised by the protoplasm is evidently, as the alterations of form of the gas-vesicles show, different in different places of the surface of the air-bubbles, and is at every point liable to constant modification.

The modifications, which the volume of the gas-vesicles undergoes, almost always take place simultaneously and in like degree in all air-bubbles of the same Arcella. To this there are, however, not a few exceptions. Often some increase or diminish more rapidly than the others. It may even happen that one air-bubble diminishes while another increases. All these modifications are usually quite conformable to an end. The development and increase of the gas-vesicles tends to bring the animalcule into such a position, that it may be able to attach itself by means of its pseudopodia. When this object is attained, the air disappears without our being able to discover another reason for this disappearance. It cannot be denied that these facts point to psychical processes in the protoplasm.

In the power of altering their specific gravity at pleasure, the Arcellæ possess a remarkable means of ascending to the surface of the water or of lowering themselves to its bottom. They make use of this means not only under the abnormal conditions in which they exist during microscopical examination, but also under normal circumstances. This appears from the fact, that at the surface of the water, in which they live, we always find specimens which contain air-bubbles. Even with a lens we can see them floating as little brown discs, in which lie one or more strongly light-refracting points.

Respecting the chemical composition of the air developed by the Arcellæ, or the mechanism of the formation and disappearance of the air-bubbles, I cannot venture to express an opinion. Yet I would

point to the development of gas observed by Heynsius and Preyer in the separation of fibrin, as a fact which might perhaps be brought into connexion with the phenomenon here described.

The discovery of the periodical development of gas in the protoplasm of living Arcellæ is important in a two-fold point of view: in the first place for the development of gas in protoplasm as a physiological phenomenon; in the second place for the voluntary nature of this development, of which this simplest of all beings (Arcellæ have the structure of Amœbæ and are therefore not much more than lumps of protoplasm) *voluntarily* makes use for the purpose of locomotion.

2. The 5th volume of the *Archief* opens with a paper by the same Author extending to 28 pages, on *The Peristaltic Movement of the Ureter*. The present state of this inquiry may be deduced from the concluding words of the essay: "The principal question however, the solution of which is to be looked for from further investigations, is this: What processes in the contractile substance give rise to the periodical contractions? In other words: What is the proximate cause of the contraction, of what nature is the automatic stimulus, and how does it arise? For the present we are satisfied with having shown, that this stimulus is produced in the contractile mass itself, therefore automatically, without the intervention of ganglionic cells and nerve fibres."

3. Among the papers of interest which have appeared during the last half year in the Swedish "*Hygiea*," the following bear more or less directly on subjects within the scope of this Journal. 1. On the so-called controlling nervous system, *résumé* by Dr Chr. Lovén. 2. On the Behaviour of the white blood-cells in inflammation in the Kidneys and Lungs, by Professor Axel Key, translated *in extenso* in the *Medical Times and Gazette*, May 22, 1869, p. 542. 3. Recent investigations on Respiration, *résumé* by Dr Chr. Lovén.

THE LATE DR CLARK.

DR WM. CLARK, F.R.S., who was Professor of Anatomy in the University of Cambridge for nearly fifty years (from 1817 to 1866), died at Cambridge on September 11, at the age of 81. Unobtrusive and very averse from display, he rarely appeared in print; but he was one of the most zealous and learned anatomists of his time; having, to say the least, as extensive, accurate and profound a knowledge of Anatomy and Physiology as any of his compeers in this country. His thoughts and time were devoted almost entirely and continuously to the prosecution of his science; and that out of pure love for it, inasmuch as he had no personal ambition to gratify and no pecuniary emolument to seek. He was one of the first to appreciate the value of the discoveries by the Germans in minute anatomy, to test the correctness of their observations and to introduce them in lectures; thus placing the Cambridge students, in this respect, in advance of those in other medical schools: and, to the last, his lectures always gave the most recent information in the several subjects of the course. He early devoted himself to the study of Comparative Anatomy, and proved his warm approval of its introduction, with other branches of Natural Science, into the curriculum at Cambridge by at once, though in his sixty-fourth year, preparing and giving an entirely new course of Lectures on the Animal Kingdom, illustrated by drawings, as well as by undertaking and completing a translation from the Dutch, and editing in two vols., with notes containing the more recent information, Van der Hoeven's excellent Handbook of Zoology. This he did, as he says in the preface, because he conceived it to be a part of his office to place within reach of our students the best assistance he could recommend for their studies. The most complete and enduring record, however, of his industry and life-long labour is to be found in the Museum of Comparative Anatomy in the University; to which he made very numerous additions, and which he recently had the gratification to see placed in a building erected for the purpose. In it is a marble bust of himself, contributed by the members of the University in recognition of his long and unwearied services.

He was educated at Trinity College; and in the Mathematical Tripos of 1808 he ranked as a high Wrangler with Lord Langdale, Mr Bland, Blomfield, late Bishop of London, and Prof. Sedgwick. He was elected a Fellow of Trinity College in 1809, on the earliest occasion when he could become a candidate for a fellowship, which was the more honourable as there were only two vacancies in that year. The late Bishop Blomfield was the other successful competitor. The warm friend of Sedgwick and Henslow, he laboured with them to give Natural Science its proper status in our Universities and our country; and success was not a little due to his being, like them, the scholar and the gentleman, a representative of science congenial to men of letters and of taste.

Journal of Anatomy and Physiology.

THE PERITONEUM OF THE HUMAN SUBJECT ILLUSTRATED BY THAT OF THE WOMBAT. By PROFESSOR CLELAND, *Galway*. Pl. VIII.

(Read at the British Association Meeting at Exeter.)

THE few words which I wish to say are not so much for the purpose of bringing forward what is new as for the sake of illustrating the views with regard to the human peritoneum which I have already brought forward in the number of this Journal for May, 1868. Those views probably require additional illustration, if I may judge from some of my Anatomical friends finding difficulty in understanding them; and the illustration which I have to offer is the more interesting, that it is derived from an animal so far removed from man as the Wombat, the arrangement of the peritoneum of the Wombat being the same as that of the human fœtus.

At an early period the alimentary tube may be considered as a mesial structure with a long loop projecting out at the umbilicus. The two ends of this primary loop are united by a narrow neck of mesentery, in which lies the trunk of the superior mesenteric artery, which is the artery of the loop. The upper end of this loop is at the pylorus, while from the lower end is formed the right half of the transverse colon. In the case of that part of the loop which forms the jejunum and ileum, the elongation of the intestine is accompanied with a commensurate growth of the mesentery; but this is not the case with the duodenum, for the duodenum appears to be formed by the intestine at the upper extremity of the loop becoming elongated from the pylorus towards the right side and downwards, and pushing its way underneath the peritoneum of the parietes, as must be supposed, till by its downward growth it has reversed the position of the extremities of the loop and made the upper extremity to occupy the lower position. Similarly to the

duodenum at the upper end, the ascending colon is elongated by growth of the lower end of the loop, progressing from the neck; for at an early period the cæcum is comparatively near the neck of the loop, and while at first it is freely supported by mesentery, it afterwards, like the duodenum, pushes its way downwards in contact with the parietes, and without commensurate growth of the adjacent peritoneum.

If we now look at the part of the alimentary tube above the primary loop, we find that the lesser sac of the peritoneum and the foramen of Winslow are very easily accounted for. The small curve of the stomach is morphologically its anterior border, and the gastro-hepatic omentum is a mesial structure formed on the under surface of the liver, precisely as the falciform ligament is formed on the upper surface of that organ, the peritoneum passing back on each side of the hepatic vessels and ducts, just as it passes back on each side of the umbilical vein. So also it may not be too much to consider the two layers of peritoneum which proceed from the great curve of the stomach, as being primarily, or morphologically, a mesial mesogastrium behind the stomach, and having the spleen developed between them, in similar relation to the back of the stomach as the liver bears to it in front. But as the stomach turns over on its right side and assumes its subsequent form, the mesogastrium grows still more redundantly and forms the pendulous omentum, while the free edge of the gastro-hepatic omentum does not grow proportionally, but remains as the anterior limit of the foramen of Winslow.

Passing now to the consideration of the intestine below the primary loop, we find that at a period when the assumed changes in connection with the stomach have been completed, the left half of the transverse colon, and with it the descending colon, are attached to the parietes by a mesial meso-colon. But as the process of growth goes on, the state of matters becomes the reverse of what took place in the instance of the stomach, for the meso-colon grows less rapidly than the intestine to which it is attached; and by want of development of its left layer, it causes the descending colon to be at last applied to the parietes, and to be partially denuded of peritoneum.

This brings the development of the peritoneum to the con-

dition described by Haller and others as permanent. For the production of the disposition more frequently found in the human adult, the further change necessary is that the same process by which the left layer of the descending meso-colon is arrested in development should extend further up so that the layer superior to the transverse colon, instead of passing back to the parietes, shall pass directly into the superficial layer of the pendulous omentum. The difficulty in conceiving how these changes take place arises altogether from forgetting that while they are going on there is likewise a rapid increase in the whole dimensions of the viscera.

In the accompanying figure of the liver, stomach, and intestine of the wombat, various large portions of intestine are supposed to have been removed for clearness, namely, two portions of the small intestine and two portions of the large. The duodenum is crossed by the transverse colon precisely as in the human subject, and the intestine between the parts which cross is seen to continue in the form of a greatly convoluted loop not otherwise attached to the parietes; the cæcum and ascending colon forming part of this pendulous loop. This is precisely the state of matters which exists in the human fœtus of the third month; and as in the human fœtus, so also in the wombat, the colon, beyond the primary loop, is connected with the parietes by a mesial meso-colon.

Below the pylorus the line is seen by which the mesentery of the primary loop springs from the parietes; and one can easily perceive how that line is originally continuous with the line of attachment of the meso-colon beneath it. Further, the drawing illustrates the truth of my assertion previously made, that the pylorus and the colon are from the first closely connected, and that the statement of the existence of a meso-colon unconnected with the stomach can refer only to the part of the colon to the left of the middle line.

Description of Plate I. representing the liver, stomach, and intestines of the Wombat.

L. L. L., liver; G., gall-bladder; S., stomach; Spl., spleen; C. C., cut ends of ascending colon; C′. C′., cut ends of descending colon; I. I. I. I., cut ends of small intestine; D., duodenum: Cæc., cæcum; App., appendix cæci; R., rectum.

CAUSE OF THE SUPERNUMERARY LOBE OF THE RIGHT LUNG. By PROFESSOR CLELAND.

As giving additional importance to the note by Dr Chiene in the last number of this Journal, I may be permitted to mention that in the month following its publication my attention was drawn by Mr Ward, my Demonstrator at that time, to a subject in the dissecting room in which he had made a careful dissection of a supernumerary lobe of the right lung, which I at once recognised as precisely similar to that described by Dr Chiene, namely, passing upwards from its origin near the root of the lung, lying in a pleural pouch, and with the vena azygos in front of it. The supernumerary lobe was, however, in this instance, considerably smaller than the one described by Dr Chiene. The very slightest consideration will convince any one that there must be some very explicit cause for this supernumerary lobe, that it is more than the result of a mere accidental tendency to redundant lobulation of the lung; for it is in the highest degree improbable that such a tendency should, without some special reason, exhibit itself twice by the formation of lobes precisely similar in their position and relations, and with those relations so peculiar. I venture therefore to suggest what appears to me to give a satisfactory explanation of the phenomenon.

The great vena azygos, in its early development, passes upwards to open into the transversely situated right duct of Cuvier. By the descent of the heart from the cervical region into the thorax, the right duct of Cuvier becomes the vertically placed vena cava superior, and the great vena azygos is bent downwards, till its terminal part becomes horizontal. What I believe, then, has taken place to produce the supernumerary lobe is, that there has been at a very early period a slight adhesion of the lung to the thoracic wall, or, much less probably, an undue curvature of the embryo, so that the vena azygos as it bent downwards to a position at right angles to its original direction, instead of slipping behind the pleura and lung, dragged down a fold of the former, and deeply notched the latter.

ON THE ACTION OF THE INORGANIC SUBSTANCES WHEN INTRODUCED DIRECTLY INTO THE BLOOD (MAGNESIAN GROUP). By JAMES BLAKE, M.D., F.R.C.S. *San Francisco, California.*

AMONGST the numerous experiments I have made for ascertaining the reactions produced by inorganic compounds when introduced directly into the blood, none have offered more interesting reactions than the isomorphal magnesian group; including as it does the salts of magnesia, lime, zinc, iron, copper, manganese, nickel, cobalt and cadmium. From what we know of the ordinary toxicological and therapeutical action of these substances it might have been supposed that no group could have been found which would have presented greater contrasts in the direct physiological action of its different members. Under a therapeutical and toxicological point of view, no classification could appear more unnatural than that which should bring together magnesia, iron, copper and zinc as producing the same reactions in the living animal. The following experiments will show however that all these substances when introduced directly into the blood give rise to analogous reactions, or are followed by the same series of physiological phenomena; the only difference in them being in the quantity of the different salts required to produce these reactions. In the following experiments the tubes by which the substances were injected directly into the blood-vessels being connected either with the jugular vein or the axillary artery, the hæmadynamometer when used was connected with the femoral artery. The pressure is given in inches of mercury. In order to ascertain the general symptoms the animal was left at liberty, the substance being injected through a tube inserted into the jugular vein.

SALTS OF MAGNESIA.—*Exp.* 1. The animal was a strong healthy dog weighing about 18 lbs. Six grains of sulphate of magnesia dissolved in about ½ oz. of warm water was introduced into the jugular vein. In 10″ the pulsations of the heart were quick-

ened, the oscillations in the hæmadynamometer, which before the injection were 2 to 2½ in. at each pulsation, were reduced to 0·2 to 0·3 in. In 5′ the action of the heart and the oscillations were the same as before the injection. Injected 16 grains. In 7″ the respiration was affected, being deeper. In 10″ the heart was affected as before. In 30″ the pressure in the arteries fell about 2 inches, oscillation about 0·2 in. In 45″ after the injection the animal appeared to be uneasy, respiration more laboured. After five minutes injected 25 grs.: in 7″ the respiration deeper. In 30″ partial spasmodic contraction of muscles; the pressure in the arteries was diminished about 0·5 in.; heart's action quick, oscillation slight. 60 grs. in 3 oz. of water arrested the action of the heart in 8″. The pressure in the arteries fell rapidly, being at 0 in about 30″.—Only one or two respiratory movements took place after the arrest of the heart's action. On opening the thorax the heart was found quite still with the exception of slight contraction of the inter-ventricular septum; both cavities filled with blood, in the right dark, in the left scarlet: the blood coagulated but not firmly.—Lungs scarlet, elastic.—Diaphragm did not contract on irritating the phrenics three minutes after death.

Exp. 2.—The animal was a healthy dog weighing 16 lbs. A tube was inserted into the right axillary artery, the point directed towards the aorta, the pressure was taken in the femoral. 16 grs. of the sulphate of magnesia was injected into the axillary artery—violent struggles commencing immediately after the injection prevented the direct effect on the pressure in the arteries being observed:—1′ animal quiet, pressure 1 in. lower, oscillations not so great. In five minutes all effects of injection appeared to have passed except that the pressure in the arteries was rather lower. Inject 30 grs.:—apparently considerable pain; and in 40″ a general spasmodic contraction of the muscles; this soon disappeared, and the pressure in the arteries was rather lower. The animal after a few minutes appeared not affected. 60 grs. injected into the artery arrested the respiratory movements: in 7″ there was a state of general tonic spasm; and in a minute and a half the animal was dead. The heart continued to beat regularly, its movements being arrested by asphyxia. The blood coagulated imperfectly.

Exp. 3.—Dog, weighed 10 lbs. not confined. 8 grs. of the salt was injected into the jugular: 10″ slight dyspnœa: 12″ animal fell down as if suddenly paralysed. It got up almost immediately and walked about 2′ vomiting. After this the animal seemed not at all affected. 14 grs. injected: 12″ animal fell on its side, legs extended, no spasm: the legs remained in any position they were placed; no expression of pain, although the animal was perfectly sensible; respiration regular. After remaining on its side almost motionless for 10 minutes, the animal rose and walked about; its movements were unsteady. 35 grs. arrested the action of the heart; animal fell in 12″; in 30″ respiratory movements arrested and animal dead; blood coagulated imperfectly.

SALTS OF ZINC.—*Exp.* 4. The animal was a strong healthy dog weighing 15 lbs. A solution containing 3 grs. of sulphate of zinc was injected into the jugular: in 10″ the respiration was affected and the action of the heart rendered slower: in 15″ the pressure in the arteries began to fall, and in 35″ it had diminished from 5-6·5 in. to 3-3·5 in.: after five minutes the pressure was still down to 4-4·2 in.: oscillations slight. Injection 6 grs.: no apparent immediate effect on the action of the heart; but in 15″ the pressure in the arteries began to fall, and in 30″ it was only equal to 2 in.; the respiration was irregular: 1′ efforts to vomit; 2′ heart stopped but respiratory movements and efforts to vomit continued: 1′ after the pulsations of the heart had apparently ceased, at least the pressure in the arteries had sunk to zero. On opening the thorax immediately after death the heart was found motionless; both cavities contained blood, but the right was most distended. In the right cavities the blood was dark, in the left scarlet, but not so bright as ordinary arterial blood. There were slight contractions of the right auricle after the blood was let out. The blood did not coagulate after death.

Exp. 5.—A solution containing 6 grs. of sulphate of zinc was injected into the axillary artery of a dog weighing 10 lbs. There was immediate expression of pain and partial spasm; 45″ the animal quiet, the pressure in the arteries was about 1 in. lower; oscillations not so great: 2′ vomiting. Inject 15 grs.:

5″ respiration suspended, spasm, retraction of head, animal dead in two minutes. The heart continued beating 3′ after respiration was suspended and after the thorax was opened. The pressure in the arteries was 2 in. Both cavities of the heart contained blood, the right most distended. The blood in the left cavities was rather more florid than in the right but not scarlet; it did not coagulate. Lungs not at all engorged.

Exp. 6.—Dog, weighing 8 lbs.; it was not confined. Inject 3 grs. of sulphate of zinc into the jugular, no marked effect. Inject 6 grs.: 12″ after the injection the animal fell down and lay on its side perfectly powerless; no spasm; 45″ efforts to vomit, urine and fæces passed; the animal lay for some minutes perfectly still, the respiratory movements became slow; action of the heart slow and weak so that its pulsations could not be felt through the chest but pulsation in the femoral; sensibility unimpaired; no expression of pain. After 10′ inject 3 grs.; 15″ some slight movements as if the animal was uneasy; respiration slower, ceased at 2′. 30″; no convulsions. On opening the thorax the heart was found pulsating slowly but rhythmically. Both cavities contained blood, that in the left rather brighter than in the right, but not scarlet; lungs natural.

Exp. 7.—A strong solution of the salt was injected into the jugular of a dog weighing 12 lbs.: in 7″ the pressure in the arteries began to sink, and in about 45″ was at zero; no pulsation of the heart after 7″; animal dead in 1′. 30″. On opening thorax, heart motionless; scarlet blood in left cavities, did not coagulate, heart insensible to scratching, lungs pearly white colour.

SALTS OF MANGANESE.—*Exp.* 8. Dog, weighed 11 lbs. Inject 5 grs. of Sulphate Manganese: 10″ heart's action affected, oscillations less; no sign of pain; pressure diminished 1 in.: 1′. 30″ vomiting. Inject 10 grs.: heart stopped 10″: animal died 1′. 45″. On opening the thorax heart still, both cavities full of blood, in the right dark coagulated, in the left scarlet and fluid and did not coagulate.

Exp. 9.—Dog, 9 lbs. not confined. Inject 3 grs. into the jugular: 20″ animal fell on its side, again rose and walked about, lay down again in 2′, lay perfectly still in the same

position for ten minutes although it could walk when roused. It remained five minutes, without moving, the head and thorax resting on the ground, the back part of the body supported by the hind legs; there appeared a total absence of volition; no expression of pain; no convulsions. Inject 4 grs.: animal dead in 2′. The post-mortem appearances the same as in the last experiment. The blood from the left side coagulated very imperfectly, only a loose film of fibrine after standing some hours.

Salts of Cobalt.—*Exp.* 10. Dog, weight 13 lbs. Inject 5 grs. sulphate cobalt: 12″ heart affected, 15″ respiration rather deeper, the pressure diminished; at 3′ it had fallen 3 in.; efforts to vomit: after 10 min. the animal appeared not to suffer. Inject 10 grs.: blood in tubes coagulated, but in 3′ the pressure was 2·5 in., it having been before the first injection 8-9 in.; respiration slow; heart's action weak. Inject 10 grs.: in 10″ heart stopped; respiration continued 2′ longer. On opening the thorax the heart was still irritable but did not contract rhythmically; both cavities contained blood, right dark, left scarlet; no coagulation after 24 hours, but it was not fluid enough to allow complete subsidence of the corpuscles.

Exp. 11.—Dog, 15 lbs., unconfined. 4 grs. sulphate of cobalt was injected into the jugular: 45″ the animal lay on its side, respiration rather slower; 3′ vomiting; at the end of half an hour the animal still disliked moving; although it could walk it would remain in any position in which it was placed; respiration slower. Inject 10 grs.: prostration complete, animal lies like a dead mass; respiration slow, regular, action of heart weak. After 10′ it could stand. Inject 15 grs.: 10″ animal fell on its side; head drawn back; struggled a little; respiration stopped 2′. On opening the thorax the heart was found motionless; but after a minute it again commenced to pulsate rhythmically but slowly, and beat about a minute and a half. Both cavities contained blood, that in left scarlet; it did not coagulate; there were two or three respiratory movements after the thorax had been opened.

Salts of Nickel.—*Exp.* 12. Dog, weight 20 lbs., pressure 5 to 7 in. Inject into the jugular 3 grs. of sulphate of nickel:

10″ heart affected, quicker; oscillations less; 45″ pressure 4·2 in.: 2′ efforts to vomit. 5′ inject 6 grs.: 12″ heart quicker; respiration deeper; 2′ pressure 3 in.; respiration quiet, slow; pulsations 58; animal appears not to suffer, lies quiet. 8′ inject 9 grs.: heart stopped in 14″; respiration continued 2′. 30″. On opening the thorax heart moving slightly, no rhythmical movement; both cavities full of blood, in right dark, in left scarlet; did not coagulate although I had noticed on introducing the tubes that the blood coagulated more readily than usual.

Exp. 13.—Dog, weighed 12 lb., unconfined. 3 grs. of sulphate of nickel was injected into the jugular: no immediate effect; 3′ vomiting; 7′ inject 6 grs.: animal fell down 30″; no expression of pain; no convulsion; breathing regular, slow; sensibility unchanged; remained in this state for some time without the slightest voluntary movement. Inject 10 grs.; heart stopped, animal dead in 2′. On opening the thorax the appearances as in the last experiment.

Salts of Cadmium.—*Exp.* 14. Dog, weighed 30 lbs. unconfined. 1 grain of sulphate of cadmium in 2 oz. water was injected into the jugular; no appreciable symptoms. Inject 2 grs.: 30″ animal appeared dull: 1′.30″ vomiting. 5′ inject 3 grs.: 45″ vomiting renewed: 4′ animal fell down, lay like a dead mass: respiration regular but slow; no symptoms of pain. On being placed on its feet it would stand for a few seconds but then gradually sunk down. Inject 6 grs.: respiration stopped in 1′. 45″. On opening the thorax heart still, both sides full of blood, right dark, left scarlet, coagulated very imperfectly, a slight film forming after standing some hours.

Salts of Copper.—*Exp.* 15. Dog, weight 15 lbs. Inject 3 grs. sulphate of copper into the jugular: 12″ the action of the heart affected; pressure which before the injection was 4·5-6·5 in. in 30″ 5·0-5·5 in., 2′ heart slower. Inject 6 grs.: 10″ heart fluttering for a few seconds: 45″, pulsations slower, from 84 to 55; respiration slower; pressure in arteries diminished 2 in.; efforts to vomit. Inject 15 grs.: 12″ heart stopped; respiration continued 1′. 30″, then arrested for 45″, then recommenced and continued slowly for 35″, the heart apparently beating feebly

although no effect was produced on the pressure in the arteries; 3′ animal dead. On opening the thorax the heart was still with the exception of partial contractions of the interventricular septum. The right cavities were full of dark blood, left contained a smaller quantity of blood, rather brighter but not scarlet, blood coagulated imperfectly.

Exp. 16.—Dog, weight 18 lbs. A solution containing 10 grs. of sulphate of copper was injected into the axillary artery: 10″ general tonic spasm which lasted 40″; respiration then recommenced and continued about 1′; the pressure in the arteries fell gradually, the heart being stopped by asphyxia. On making an incision into the parietes of the thorax 3′ after the animal had been to all appearance dead a full inspiratory movement of the parietes of the thorax and of the diaphragm took place. Both cavities of the heart contained blood, that in the left was rather brighter than in the right; blood coagulated imperfectly.

Exp. 17.—Dog, weight 12 lbs. not confined. Inject 3 grs. sulphate of copper into the jugular: 35″ the animal seemed uneasy but no expression of pain, respiration rather deeper: 2′ vomiting. 5′ inject 4 grs.: 12″ respiration deeper, more laboured: 20″ animal lay down, stretched out its legs and cried; no convulsion; sensibility unimpaired: 2′ rolled over on its back: 3′ respiration short and quick: 4′ efforts to vomit, and the animal rose for a short time but soon fell again. 6′ inject 4 grs.: 12″ respiration deeper: 45″ respiration stopped; no convulsive movements, but perfectly still: 1′. 30″ respiration again began and continued at intervals for 1′. 30″; eye closed on irritating conjunctiva 2′ after injection. On opening the thorax the ventricles were found contracting slightly; auricles still. Left cavities contained blood rather brighter than in the right; blood coagulated very imperfectly.

The action of the ferrous salts, another member of this isomorphous group, has already been described in this *Journal* (see No. 3, *Nov.* 1868). As regards the salts of lime their action will be described when treating of the salts of the baryta group, a group with which they have well marked isomorphous relations, and with which they are also connected by their physiological action.

The facts described in the above experiments point out a close agreement between the physiological action of substances possessed of very different therapeutic and toxicological properties. I shall not however enlarge at present on this point, as a more fitting opportunity for discussing it will be offered when experiments that have been performed with substances of other isomorphous groups have been published.

The most marked reaction in the experiments above related would seem to be on the nervous system: the effect on the respiration, the vomiting, the prostration, and even the more ready passage of the blood through the capillaries, may I think be accounted for by their action on the nervous centres; although it is possible that this last fact may be connected with the changes produced in the blood, changes by which its coagulation after death is prevented. The above symptoms, together with the absence of convulsions, the freedom from pain, and the unimpaired sensibility, suffice to distinguish the physiological action of the substances of the magnesian group from that of any other isomorphous group.

ON THE ORGANIC MATTER OF HUMAN BREATH IN HEALTH AND DISEASE. By ARTHUR RANSOME, M.D. Cantab. Manchester.

THE following analyses of the amount of organic matter contained in human breath were made by the method of Water-analysis invented by Messrs Wanklyn and Chapman. The aqueous vapour of the breath was condensed in a large glass flask, surrounded by ice or snow and salt, by which a temperature of several degrees below zero was obtained. In the first essays the number of breaths was counted, and the flask washed out with distilled water; but this was soon found to be unsatisfactory, as the extent of the expirations varied so greatly. The aqueous vapour was then collected and measured and tested as follows.

If enough fluid had been obtained, a certain quantity (generally about 20 minims) was mixed with 50 c. c. of distilled water, and tested for free ammonia by means of the Nessler test. An equal portion of the fluid was then mixed with 30 minims of a saturated solution of carbonate of soda and about 10 oz. of pure distilled water, ascertained, by further distillation, to be free from ammonia. The mixture was then distilled and the distillate tested for ammonia until it ceased to give any indications of its presence. This testing would give all the free ammonia, together with any of this gas arising from the action of the carbonate of soda—for instance, from the decomposition of urea[1]; 50 c. c. of a strong solution of permanganate of potash and caustic potash were then added to the retort and distillation again continued; the quantity of ammonia now given off would arise from the destruction of organic matter. The results of these examinations are given in the following tables. Table I. giving the records relating to healthy breath. Table II. of breath from persons affected by various disorders. In both Tables are given in successive columns (1) the number of the observation, (2) the nature of the case, (3) the period of the

[1] See *Water Analysis*, by Wanklyn and Chapman. Trübner and Co. p. 55.

day, and (4) the extent of breathing; then follows in millegrammes the amount of free ammonia or ammoniacal salts determined (5) directly by the Nessler test, and (6) by distillation with carbonate of soda; a column (7) is then provided for any difference between these two readings, giving the ammonia from urea, or other matter decomposable by the weak alkali. The ammonia obtained by oxidation of the organic matter comes next, (8) then the total amount of ammonia obtained, (9) and (10) a calculation of the quantity of ammonia to be obtained from 100 minims of the fluid collected; finally a note is appended to those cases in which any peculiar microscopic appearances were observed.

The number of examples I have collected is still small, but they are brought forward now in the hope that others may be induced to undertake the same enquiry. It is one which requires many observers, and I think that the results so far as they have been obtained justify the attempt to enlist others in the work.

I. Healthy Breath.

The breath of 11 healthy persons was examined and the quantity of aqueous vapour was ascertained in 7 instances. The persons examined were of different sexes and ages, and the time of the day at which the breath was condensed varied.

It may be observed that the amount of free ammonia varies considerably, and I have not so far been able to connect the variation with the time of the day, the fasting or full condition.

It has been stated by more than one observer that urea is sometimes present in the breath, it was therefore sought for in 15 instances, 3 healthy persons and 12 cases of disease, but it was only found in two cases of kidney disease, in one case of Diphtheria, and a faint indication of its presence occurred in the breath of No. 8, Table II, a pregnant female suffering from catarrh[1]. The quantity of ammonia arising from the destruction of organic matter also varies somewhat, possibly from the oxidation of albuminous particles by the process of respiration; but it may be noticed that in healthy persons there is a re-

[1] No Albuminuria was present in these two last cases.

	from odour.										
17	Male. Senile. Gangrene.	70	7 P.M.	m xx.	....	0.01	....	0.02	0.03	0.150	
18	Female. Phthisis, abundant expectoration, incipient albuminuria. (Dr Roberts.)	17	4 P.M.	m xxiv.	m xij. 0.005	m xij. 0.02	0.015	0.06	0.08	0.666	
19	Male. Albuminuria slight, under hydropathy.	68	11 A.M.	15 minutes. m xl.	m xx. 0.02	m xx. 0.02	0.	0.08	0.10	0.500	
20	Male. Albuminuria. Uræmia impending. P.M. week after: large white kidney. (Dr. Roberts.)	13	4 P.M.	m xl.	....	m xl. 0.12	....	0.21	0.33	0.825	
21	Male. Albuminuria. Dropsy. P.M. in 2 weeks. Large white kidney. (Dr Morgan.)	45	4 P.M.	m xl.	m xx. 0.045	m xx. 0.08	0.035	0.10	0.18	0.900	
22	Rheumatic Fever. 12th day.	32	3 P.M.	m x.	....	m x. 0.010	....	0.02	0.03	0.300	A few red bodies.
23	Male. Albuminuria. Heart disease, Congestion of Lungs. Hæmoptysis. (Dr Roberts.)	40	4 P.M.	m xxiv.	m xij. 0.025	m xij. 0.025	0.	0.04	0.065	0.545	

markable uniformity in the total quantity of ammonia obtained by the process: amongst adults the maximum quantity per 100 minims of the fluid collected was 0·425 and the minimum is 0·35 millegrammes. It is not easy to estimate the total quantity of organic matter thus got rid of by the lungs of even healthy persons. We are told by Messrs Wanklyn and Chapman that every part of organic ammonia discovered corresponds to about 10 parts of albuminous matter, but, on the other hand, the quantity of aqueous vapour carried off by the breath varies with age and season. If, however, we take the ordinary quantity of this fluid, for an adult, to be about 10 oz. in the 24 hours, and the average amount of ammonia given off as 0·4 of a millegramme in every 100 minims of fluid, then we obtain the rough approximation that in ordinary respiration about 0·2 of a gramme or 3 grs. of organic matter is given off from a man's lungs in 24 hours. At first sight this seems to be a very minute quantity to be thus disposed of; but when it is considered that the most impure water, examined by the authors of the process, only contained 0·03 of a gramme of organic matter per *litre*, it will be allowed that there is ample quantity to permit of putrefaction, and to foster the growth of organic germs.

We cannot doubt that the diseases which arise as a consequence of overcrowding, find at least a starting-point in the impure vapours arising from the lungs, and the general surface of the body.

II. In Disease.

In diseased states of the system we find a much greater variation in the amount and kind of organic matter given off. The breath of 23 cases of disease was examined. In 3 cases of Catarrh, in 2 of measles, and 1 of Diphtheria, the total ammonia obtained was much less than in health; a result which is probably due to the abundance of mucus in those complaints by which the fine solid particles of the breath were entangled. The cases of whooping-cough were children, and therefore the deficiency noted in the organic matter given off by them may be due to age, and this is the more probable since the only healthy child's breath examined contained about the same

quantity (0·275 of a millegramme) of organic ammonia, considerably less than the breath of any healthy adult.

In two cases of Phthisis, with abundant expectoration, the total ammonia was also less than in health; but in one case of this disease with abundant purulent sputa, associated however with Bright's disease, a large amount of organic matter was given off. We cannot doubt however that the albuminuria which was present in this case had an influence upon the result. A portion of the ammonia was in fact due to urea, or to some kindred substance; and we may perhaps ascribe the general excess of organic matter to some peculiarity in the breath due to the kidney disease. It is in truth in kidney diseases that the largest amount of organic matter of all kinds is to be found in the breath. Five cases suffering from these diseases are recorded. In two cases urea was found, in one it was not sought for, and in two others it was absent. The free ammonia in all the cases is abundant, in two of them (Nos. 20 and 21) excessively so, and the organic ammonia is also large in amount. The total quantity of ammonia found is in excess in all the cases; in one it rises as high as 0·9 millegrammes in 100 minims of fluid, and in another to 0·825.[1]

Probably if the sputa in these cases had been examined, a much larger proportion of matters decomposable by Carbonate of Soda would have been found. I would suggest that the presence of these substances either in the bronchial mucus, or in the aqueous vapour of the breath, would be a fair indication that their elimination by the kidneys and skin was deficient, and that measures should be taken to improve the action of these organs. In one case of Ozœna the total quantity of ammonia obtained was greater than in any of the healthy subjects, but the free ammonia did not seem to be in excess. In another case, however, a girl of 15, whilst the total quantity of the gas was probably not greater than normal, the free ammonia formed nearly half the amount collected.

The case of typhus fever was obtained in the fever wards of the Manchester Royal Infirmary; but it was scarcely a fair example of this disease, since it was already convalescent.

[1] 4 of these cases of kidney disease were in the Manchester Royal Infirmary, under the care of Dr Roberts and Dr Morgan.

There was however, apparently, a deficiency in the total amount of organic matter got rid of from the lungs. I might have attributed this fact to the feebleness of respiratory power, the blast of air being insufficient to carry with it much foreign matter, had not the cases of kidney disease (Nos. 18, 20, 21, and 23) been equally if not more feeble. This explanation is however still a possible one, and it is strengthened by the fact that in the case of senile gangrene, a feeble old man, but without catarrh, the organic matter of the breath is very small in quantity. The case of rheumatic fever showed no very definite peculiarity; the organic ammonia was slightly less than in health.

As a matter of curiosity, the air of a railway carriage, containing 8 persons, was examined, after 15 minutes' occupation, with the windows shut and the ventilators open. In this instance the breath was inspired through the apparatus; about 80 inspirations being taken, probably between 2 and 3 cubic feet of air would thus pass through the freezing mixture; very little moisture was condensed, but what was obtained was strongly charged both with free ammonia and organic matter (see Table I. No. 12). Befóre considering the *nature* of the organic matter to be found in human breath, it may be well to advert briefly to the prior question of the amount and kind of organic matter in the air breathed.

There has lately been much discussion as to the priority of the discovery of organic matter in both fresh and respired air. And yet it is certain that from very early times men have recognized the fact that the air is the vehicle of many substances, both organic and inorganic. The old writings are full of disquisitions upon the teeming air. Boerhaave[1] calls it the "instrumentum catholicum" and speaks of the "corpuscula... quæ in aere perpetuo obvolitent," and he shows how "Terra tota ex aere cadentia recipit omnia, ita rursum aer de Terra universa accipit. Fitque inter bina hæc perpetua, quasi omnium revolutio, distillatio assidua." Medical men of all epochs have been only too prone to ascribe diseases to the constituents of the atmosphere, and since the time of Spallanzani it has been surmised that fermentation and putre-

[1] *Elementa Chemiæ* (Leyden Ed. 1732), p. 484.

faction were the result of the action of living animals or plants whose germs were derived from the air. A conclusion which has steadily gained strength through the researches of Astier, Schwann, Cagniard de Latour, Turpin[1], and more recently of Pasteur. The great controversy which has now been going on for many years, chiefly between Mon. Pasteur and Mon. Ponchet, on the subject of spontaneous generation, turns entirely upon the difficulty of keeping out of the experimental flasks all taint of organic matter from the atmosphere.

I do not know who first used cotton-wool as a filter for the air, but it was certainly employed many years ago by different observers, Schwann, Schroeder and Dusch, Helmholtz and Van den Broek.

It is however to Dr Angus Smith that we owe the discovery of the large proportion of organic matter contained in respired air, and the readiness with which living organisms develop in the condensed breath of crowded meetings. He has also shown the presence of organic matter in the air of different places. The following table gives the quantity washed down by the rain.

TABLE III.

AMMONIA IN RAIN WATER.

Place.	Date.	Ammonia parts in 1000000, or grammes in a cubic metre.	Ammonia of Albumen.
Row, near Helensburgh...	Jan. 16, 1869	0.00	0.
Clydeford, Glasgow.........	Jan. 1869	1.25	0.0
London Hospital............	Feb. 1869	2.	0.3
" "	" "	2.2	0.3
" "	" "	3.	0.4
Glasgow, St Rollax.........	Dec. 1868	3.75	0.
Glasgow, Netherfield	Jan. 1869	5.5	0.
Manchester	Dec. 1868	6.	1.
Newcastle on Tyne.........	Dec. 1868	5. and 0.6	0.

[1] "Point de fermentation, sans l'acte physiologique d'un vegetation." *Comptes Rendus*, VII. p. 392.

In an Appendix to Dr Angus Smith's last report to the Privy Council, upon the working of the Alkali acts, Mr Dancer has remarked upon the nature of the organic matter contained in the washings of 2495 litres of the air of Manchester.

He discovered in these many forms of life, fungoid matter, sporidiæ and zoospores, and much lifeless organic substance, vegetable tissue, partially charred objects, fragments of weather-worn vegetation, hairs of leaves, fibres, cotton filaments, granules of starch, and hairs of animals. Mr Dancer makes the calculation that about "37½ millions" of spores or germs of organic matter would be contained in the quantity of air examined—an amount "which would be respired in about 10 hours by a man of ordinary size, when actively employed."

I would submit however, that in this calculation there is a serious possibility of error. There seems to have been a considerable interval of time (how long is not stated in Dr Smith's report) between the commencement of the collection of the fluid and the examination of it by the microscope. It is well known how rapidly organisms increase in numbers in suitable fluids, and it seems reasonable to believe that many of the spores discovered by Mr Dancer may have been developed in the fluid itself.

I have myself made a few observations upon the organic contents of respired air which may be interesting at the present time. In the year 1857, in consequence of a letter in the *Times* newspaper, signed 'Investigator,' I exposed glass plates covered with glycerine in different places, amongst others in the Manchester Infirmary, and in the dome of the Borough Gaol, Manchester. In this latter establishment all the air from the cells is conducted, by the system of ventilation employed, into the dome. The plates were afterwards carefully searched with the microscope, but at that time I could recognize little except fibres of cotton and wool, and shrivelled epithelial scales; there were also some singular looking bodies, but these I found afterwards were contained in the glycerine used to cover the slips of glass.

Upon another occasion during a crowded lecture at the Free Trade Hall, about 3000 persons being present, I drew the air from one of the private boxes (raised about 40 ft. above the

audience) by means of exhausting bellows, through a system of narrow tubes, filled with distilled water; the operation being conducted for a space of about 2 hours. The water was emptied from the tubes, allowed to settle for 36 hours, and the sediment was examined microscopically. The following objects were noted at the time and sketched under the microscope, the ¼ inch power being used:—fibres; separate little cellules; nucleated cells, surrounded by granular matter (about 6 in 1 drop of water); numerous scales like degenerated epithelial scales.

The dust from the top of one of the pillars in the private boxes which had not been disturbed for three weeks, was also examined shortly afterwards, and the following objects were noted as being present:—1. A few fibres of cotton and wool. 2. Variously shaped and sized black masses, which were taken to be specks of coal dust. 3. Semi-transparent little lumps refracting light strongly. 4. Crystalline substances having a laminated texture (query fragments of glass). 5. Shrivelled pieces of membrane, epithelial scales. 6. Collections of granules. 7. Variously coloured fragments, blue, pink and yellow; probably portions of dress.

I have also searched with the microscope most of the specimens of aqueous vapour from the lungs. In all of them epithelium in different stages of deterioration was abundantly present, and a difference in the appearance of the scales could be marked according to the age of the patient, those from young persons being notably the most perfect and fresh looking. In one case of kidney disease, the only one examined, they had a granular appearance. Probably a large portion of the organic matter of the breath consists of these epithelial particles. Very few spores were found in any fresh specimen; but, on the other hand, after the fluid had been kept in some instances for only 12 hours, even in a cold room, myriads of active vibriones and many spores were found. In several instances—in one healthy person, in two cases of ozœna, in one case of measles and one of rheumatic fever—very abundant specimens of the red and yellow bodies, called "pigmentary particles" by Dr W. Roberts[1], were found, and it was noticed that after being kept for a day

[1] *On Urinary and Renal Diseases*, p. 83.

or two, the colour of these bodies darkened materially. In one case of diphtheria, straight-celled, greenish-coloured, confervoid filaments were noticed; and in three other cases, two of measles and one of whooping-cough, abundant specimens of a small round-celled conferva were found, resembling the Penicilium glaucum, and these were seen to increase in numbers and in size for two days, after which they ceased to develop.

It may be interesting to note that the fluid in which these objects were found was neutral or slightly alkaline, whereas the mould-fungus generally prefers a slightly acid fluid. These differences in the nature of the bodies met with are interesting as showing some occult differences in the nature of the fluid given off in the several cases, but many additional observations would be needed before we could draw any inferences from them.

They certainly do not as yet afford any proof of the germ theory of disease, nor do they justify the alarming doctrines which have been rife of late, as to the presence of organisms in the breath. They simply show the readiness with which the aqueous vapour of the breath ferments or putrefies, and the consequent danger of overcrowding, and the paramount importance of ventilation.

ON THE CEREBRAL CONVOLUTIONS OF A DEAF AND DUMB WOMAN. By W. H. BROADBENT, M.D., F.R.C.P., *Lecturer on Physiology at St Mary's Hospital Medical School, &c.* (Pl. IX. & X.)

THE following are some of the objects sought to be attained by a careful study of the convolutions of the cerebral hemispheres.

1. To ascertain if there is any constant difference between the right and left sides of the brain which may throw any light on the apparent difference in function exemplified in the association of aphasia, so called, with injury of the *left* frontal lobe.

2. To trace the gradual development of the characters which distinguish brains capable of the highest intellectual operations.

From this point of view it will be interesting to examine the cerebrum in individuals belonging to the Negro, Mongol, and other pure races, so as by comparison of one with another, and of all with the brains of the Bushwomen figured by Gratiolet and Marshall, and with the brains of the primates generally, to ascertain how far the development has been linear and general or divergent and partial.

It will be interesting also to examine the cerebral hemispheres of new-born infants and of young children at different ages, so as to learn how far the subsequent growth is by simple enlargement of convolutions present at birth, how far by the interposition of new convolutions. A comparison of infantile brains of the intellectual classes and of the classes subsisting by manual labour, would be of course necessary to the elucidation of this question.

3. To endeavour to connect varying degrees of intellectual power and peculiarities of mental constitution with peculiarities or differences in the arrangement and complexity of the convolutions. This would be to construct a scientific phrenology. The brains of idiots will be of great use in this part of the investigation. It has always seemed to me a mistake to select for examination and representation the extremely degenerate brains

of the lowest idiots, the most valuable results will be obtained from those cases just on the one or other side of the line of idiotcy, or in which some mental faculty is abnormally predominant.

4. Still another object which led me to seek for the brains of deaf and dumb or congenitally blind individuals will be explained by a quotation from a paper by Dr Bastian, "On the Muscular Sense, and on the Physiology of Thinking." "I start," he says, "with the presumption that in the higher phenomena of mind, which are dependent upon the cerebral hemispheres, certain definite parts of these are always called into activity whenever similar mental operations are repeated. . . . . I also assume that the several sense-centres at the base of the brain and in the medulla, are connected in a perfectly definite way, each with its own set of cells in the cortical substance of the hemispheres; these cells, in connexion with the several sense-centres constituting their respective *perceptive centres*, which may exist in regions of the hemispheres either distinct from one another, or which may be variously interblended. In the perceptive centres, the primary impressions made upon the organs of sense are converted into 'perceptions' proper; that is to say, they receive their intellectual elaboration, and this elaboration implies an intimate cell and fibre communication between each perceptive centre, and every other perceptive centre, since one of the principal features of a perceptive act, is that it tends to associate as it were into one state of consciousness much of the knowledge which has been derived at different times and in different ways concerning any particular object of perception. An impression of an object, therefore, made upon any single sense-centre, on reaching the cerebral hemispheres, though it strikes first upon the corresponding perceptive centre, immediately radiates to other perceptive centres, there to strike upon functionally related cells, all this taking place with such rapidity that the several excitations are practically simultaneous, so that the combined effects are fused into one single perceptive act."

Speculations similar to these had, previously to the appearance of Dr Bastian's paper, suggested to me the idea that in the brains of the deaf and dumb and of the congenitally blind,

there might be unused areas or tracts of convolutions which might in consequence have failed to undergo development corresponding to the general development and growth of the hemisphere. In this case the cerebral convolutions of the deaf and dumb and blind might be expected to exhibit more or less constant and definite peculiarities, which by examination and comparison of many examples might be made out. The deaf and dumb, again, are deprived of the faculty of giving expression to their ideas by articulate language; a most important "way out" for the products of intellectual operations, to adopt a term introduced by Dr Hughlings Jackson, therefore remains unused, and the convolutions which serve as the downward starting-point of the ideo-motor impulses which give rise to spoken words might be expected to stop short in their growth. At any rate since the blind and deaf each specially cultivate perceptive faculties of which the others are deprived, and since the entire basis of their mental operations must be different, a comparison of their cerebral hemispheres with each other and with those of persons possessing both sight and hearing cannot fail to be interesting.

In the brains I may have the opportunity of examining personally, I shall endeavour to connect any modification in the arrangement of the convolutions exhibited on the surface, with the concomitant modification in the course and connexions of the fibres in the substance, passing between the crus and central ganglia and the cortical grey matter on the one hand, or between different convolutions on the other. I may state that repeated and careful dissections have led me to the conclusion that the fibres radiating from the crus and central ganglia are distributed mainly to the two extremities of the hemisphere and along the upper and outer edges, *i. e.* along the margin of the great longitudinal fissure above, and along the third frontal gyrus and the upper edge of the fissure of Sylvius below, the fibres of the corpus callosum passing mainly to the same parts though in different proportion. Of the remaining convolutions it may be said with certainty that some receive no fibres whatever from the crus, central ganglia, or corpus callosum, *e. g.* those on the internal flat surface of the hemisphere, those of the orbital lobule except at the margin, those

of the under surface of the temporo-sphenoidal lobe, except around the edge, and those of the Island of Reil. Those on the convex outer surface of the hemisphere receive few as compared with the two margins. The mass of white substance is composed of fibres passing from one part of the hemispherical surface grey matter to another in large commissural systems, and the convolutions indicate, not as Gratiolet states, the distribution of the central radiating fibres, but the course of the superficial commissural or "proper" fibres.

It at once occurs to the mind that the convolutions in direct relation with the crus and central ganglia will constitute the "perceptive centres" on which impressions travelling upwards first impinge, and the downward starting-point of volitional impulses, while those convolutions which are withdrawn, so to speak, from immediate relation with the outer world, will be the seat of the more purely intellectual operations; and it is in effect in the superadding of these gyri that the difference between the higher and lower primates, and between man and the primates consists[1].

The first brain to be described is that of a deaf and dumb woman who died from accident in the Middlesex Hospital under the care of Mr C. H. Moore, to whom I am indebted for the opportunity of examining it.

The brain was of the full average size for a woman, weighing on its removal from the cranium 45 oz. It presented nothing remarkable in its general appearance and conformation. It was flattened by its own weight before it came into my possession, the convolutions therefore appear in some degree distorted in the tracings[2].

[1] For fuller details see the *Proceedings of the Royal Society* for July, 1869, and *Journal of Mental Science* for April, 1870.

[2] The tracings were made by the following method, practised with great success by Dr Sibson from whom I learnt it, in figuring the fibres of the heart. A sheet of glass is placed over the brain as close to it as possible; the fissures and sulci are traced upon the glass in Indian ink or some other pigment by means of a camel hair pencil, the eye being carefully maintained perpendicularly over the point to be represented. If this precaution is not taken, and especially if the glass is not equidistant from every part of the object or is at some little distance above it, the result may be very erroneous. The tracing is then transcribed on thin paper placed over the glass and held up to the light, and is afterwards carefully compared with the brain so as to eliminate accidental and unimportant markings and to give due relative importance to the different fissures and sulci. Of course the convolutions appear wider than they would in a shaded drawing, but a degree of relative accuracy is obtained which will permit

External Aspect of Fronto-parietal and Occipital Lobes.

Fissures and Sulci.

1. Fissure of Sylvius, SS. Right. Ascending branch short; interrupted by origin of third frontal gyrus from anterior parietal; horizontal branch comparatively straight, its extremity surrounded by a remarkable "angular" convolution.

Left. Ascending branch longer; reaches 2nd frontal gyrus, having in it a sort of island which is a portion of the 3rd frontal partially cut off. Transverse branch extends rather farther back than on the right side, a convolution curves round its termination, but superiorly expands into a supramarginal lobule.

2. Sulcus of Rolando, RR. Right extends at about the usual slope from near the fissure of Sylvius to near the median fissure. Left has its lower end nearer the Sylvian fissure, but its upper not so close to the edge of the hemisphere.

3. Intra-parietal Sulcus, IP. Right does not reach the fissure of Sylvius below, is intercepted by the angular convolution mentioned, above extends to near the edge of the hemisphere. Left bends forwards at its lower end into the second ascending parietal gyrus, does not reach the median fissure.

4. External parieto-occipital fissure, PO. Right wide and extending nearly to the parallel sulcus, cutting off the occipital from the parietal lobe. Small annectent gyri are however concealed within it.

Left very short, being at once intercepted by the first annectent convolution, but close to its termination begins a deep sulcus, PO′, which runs down to the parallel sulcus and separates the parietal and occipital lobes. This sulcus is crossed midway by another, the two forming a cruciform marking which at once arrested the attention.

Convolutions.

1. Frontal 1, 1; 2, 2; 3, 3. Right. First and second large, and each has two origins from the first parietal; the first is single but wide, the second is double. Third springs from first

of comparisons being made between different brains and between different parts of the same brain. Both hemispheres are figured and described, the association of aphasia so called with disease of the *left* frontal lobe having given a new motive for comparing the two halves of the brain.

parietal, and makes two bends upon itself before turning forward along the lower top of the lobe.

Left. First and second have each a single origin from the anterior ascending parietal with a small intercalated portion of gyrus between them. The first is single throughout and rather small; the second becomes double in passing forwards and is rather large. The third does not spring from the ascending parietal. A part is nearly cut off from its posterior extremity, and forms the small island seen in the ascending branch of the fissure of Sylvius. Including this it is smaller than the right third gyrus.

2. Parietal. The ascending parietal convolutions, one 4, in front of, and the other 5, behind, the sulcus of Rolando, present no features calling for remark. Round the end of the fissure of Sylvius on both sides is a curved convolution, and extending from the lower end of the second parietal to the infra-marginal convolution of the fissure in the temporo-sphenoidal lobe; this takes the place of the supra-marginal lobule, and apparently also of the angular gyrus or 'pli courbe.' The postero-parietal lobule, pp, has no obvious peculiarity.

3. Occipital. The convolutions of the occipital lobe seemed to be simpler than usual; the annectent or bridging gyri deficient.

Temporo-sphenoidal Lobe.

Fissures and Sulci.

1. Calcarine Fissure, Cc. Right anteriorly extends nearly across the gyrus uncinatus; posteriorly is curved and passes out on extremity of occipital lobe, and appears on the under surface at the tip. A bifurcation runs upwards. Left, does not cut across the uncinate gyrus; has a straight course, and at the top of the occipital lobe curves to the inferior aspect.

2. Collateral Sulcus, Cl. Right interrupted anteriorly, bifurcates posteriorly, the outer branch apparently being the continuation of the sulcus, and falling into a curved transverse sulcus near the extremity of the lobe. Left not interrupted anteriorly; its bifurcation encloses a larger gyrus, and its inner branch continues backwards nearly parallel with the calcarine fissure.

3. A Lateral Sulcus, L (not named), is deep and uninterrupted on the right side, much broken up on the left.

4. Parallel Sulcus, P. Right uninterrupted; has a simple termination posteriorly, but the sulcus surrounding the curved gyrus round the end of the fissure of Sylvius falls into it. Left interrupted anteriorly, posteriorly runs into the large cruciform sulcus mentioned.

Gyri. The only point calling for remark is the small size of the collateral lobule CL on the left side. (This lobule is situate nearly over the situation of the eminentia collateralis between the collateral and lateral sulci, and has been named because in it fibres end which come from the two extremities of the lobe and from the convolutions on each side. The sulci bounding it dip under it so that with a wide surface it has a slender deep attachment.)

Island of Reil. Convolutions arranged in three pairs as usual, apparently somewhat smaller and more simple than usual. No difference noted between the two sides.

The convolutions of the orbital lobule present no peculiarity, they are rather more simple on the left side which, according to my observation, seems to be the rule.

The Callosal (Cal.) and Marginal (Mar.) Gyri on the internal flat surface, the quadrilateral lobule, Q, and Cuneus, Cu, do not require description, but attention may be called to an arrangement of the commencing callosal and marginal gyri of the two sides which is met with in all brains. At this part, *i.e.* in the median fissure below the rostrum of the corpus callosum, the falx is not interposed between the two hemispheres and they not only lie in contact with each other, but are adherent and the convolutions of one fit into the sulci of the other. In the tracing it will be seen that the marginal gyrus of the left hemisphere is subdivided into three narrow folds by two sulci (the upper of which is deep, the lower shallow). The central fold was very prominent, and occupied the groove formed by the sulcus which runs along the corresponding gyrus of the right side; above and below it were grooves into which fitted prominences on the left hemisphere; and so as to the callosal gyrus. The signs + and O represent projections and depressions respectively.

Summing up the points in which peculiarities have been noted in this brain, they are the comparatively small size and simple character of the left third frontal gyrus; a deficiency of annectent convolutions, so that the occipital lobe is almost completely separated from the parietal; a deficiency in the supramarginal lobule, which allows the angular gyrus usually displaced backwards to surround the end of the fissure of Sylvius; a degree of simplicity of the occipital lobe generally, and a narrow collateral lobule in the temporo-sphenoidal lobe. These may all be merely features of general inferiority common to many brains, or perhaps some of them may be specially associated with deaf-mutism. This can be ascertained only by the examination of numerous cases. The small size of the third frontal gyrus on the left side of course challenges attention, but while signalizing the fact, I attach no importance whatever to it unless it is corroborated by other observations. The absence of annectent gyri and the almost complete severance of the occipital lobe from the parietal by the external parieto-occipital fissure on the one side, and by the sulcus prolonged upwards from the parallel sulcus on the other, are certainly remarkable but not altogether peculiar. I am inclined to look upon this condition as in some degree a feminine characteristic. The comparative symmetry and simplicity of the convolution round the end of the fissure of Sylvius constitute another feature worthy of note. The small size of the collateral lobule would probably have escaped attention had it not been attended with a remarkable simplicity in the arrangement of fibres. The one point which seems to have a certain importance is, that the degree of convolutional development does not seem to be equal at the two ends of the hemisphere; while the frontal gyri are elaborate and bridge over the ascending branch of the Sylvian fissure, so as to connect the frontal and parietal lobes, the convolutions about the parieto-occipital fissure and the posterior end of the Sylvian fissure are comparatively simple and permit of an unusual breach of continuity between the parietal and occipital lobes.

ASYMMETRY OF THE TWO HALVES OF THE BODY.

By PROFESSOR HUMPHRY.

SLIGHT deviations from the symmetry of the two sides of the body are not unfrequent; but marked deviations even at any part are rare; and a decided inequality throughout the two halves seems to be exceedingly rare. At any rate an instance of the kind so pronounced as represented by the accompanying photograph, is worthy of being recorded.

A young woman (æt. 20), came to Addenbrooke's Hospital on account of an affection of the scalp. I remarked on the peculiar appearance of her face, and was informed by her mother that she was born so and with one arm longer and larger than the other. I accordingly made a more careful investigation, and found that the whole of the right side of the body was larger than the left, the difference being most marked in the upper limb.

The measurements are as follows in inches:

	Right.	Left.	Difference.
UPPER LIMB.			
From acromion to end of middle finger	30½	28	2½
Humerus	12¾	11¾	1
Radius	10	9¼	¾
Hand	7¾	7	¾
Circumference of middle of arm	10½	9½	1
... forearm	10½	9	1½
... wrist	6¾	6	¾
... metacarpus	8½	7¾	¾
LOWER LIMB.			
From anterior spine of ilium to bottom of foot	33¼	32¾	½
Femur	17	16¾	¼
Tibia	14	13¾	¼
Foot	10½	9¾	¾
Circumference of middle of thigh	20¼	20	¼
... calf	15½	14¼	1¼

Circumference of ankle	9¾	8¾	1
.... metatarsus	10¼	9¾	½
.... heel and instep	13¼	12¼	1
CHEST, just above mamma	16⅜	15⅝	6/8

I have no doubt that the right clavicle, scapula and side of pelvis are somewhat larger than on the left, but the difference ascertained by measurement is not positive.

The right mammary gland and nipple are distinctly larger than the left. The same is the case with all the right side of the head, the cranial as well as the facial part; the right side of the crown is a little higher, and the right side of the chin is a little lower than the left; and the right side of the forehead is a little forwarder, and the right side of the occiput a little backwarder than the left. The right side of the head just above the ear from the occipital crest to the middle of the forehead measures 11 inches, and the left 10½. The right teeth both above and below are in a plane a little lower than the left; the latter do not appear to be smaller, but they are rather more crowded owing to the alveolar arches being somewhat less spacious. The raphe of the lips and chin are a little to the left of the mesial line; and the same is even more distinctly the case with the tongue. The right half of this organ, which I may observe is protruded straight, forms the tip and is altogether larger, broader, thicker and longer than the left. The right tonsil is the larger; and the end of the uvula is inclined somewhat to the left, though I cannot distinguish a difference in the size of its two halves.

The right eye appears at first sight smaller than the left. This however is evidently due to the lids of this side not being opened quite so wide as those on the left side; and the eye is evidently set a little backwarder owing apparently to the somewhat greater size of this orbit.

She can see equally well with either eye, and hear equally well with either ear; though the right outer ear is slightly larger than the left. The right arm is decidedly stronger than the left. She can lift a weight with it better than with the left; and she is right-handed. Her right leg is also stronger than the left.

She is quite healthy, in other respects well-made, and is very little inconvenienced by the disproportion between the two sides, which her mother is quite certain was congenital. Her height when standing on the right leg is 5 ft. 5 in., on the left, 5 ft. 4½ in. The apex of the heart beats in its usual place. There is no marked difference in the pulse on the two sides as indicated by the finger or the spygmograph, or in the temperature. There is not, and appears never to have been, any indication whatever of paralysis; and I need scarcely observe that this case is totally different from those of paralysis with wasting and imperfect growth of one side associated with atrophy of the opposite side of the brain described by Schroeder Van der Kolk[1].

Whether the disproportion has been caused by an excessive growth on the one side or an imperfect growth on the other, or by both, is not easy to decide. Judging from the more womanly appearance of the left side as contrasted with the more masculine character of the right, I should infer that the fault is one of excess on the larger side. Beyond this I cannot venture into the region of speculation as to cause.

The only record of a similar case which I have found is one of congenital inequality of the two halves of the body by Paul Broca in the *Gaz. Med. de Paris*, 29, p. 445, 1859, noted in Canstatt's *Jahresbericht*, 1859, IV. 6. The subject was a boy, æt. 11, in whom the left half of the body exceeded the right so much as to give the impression that he was formed by the union of two halves from two persons of different size and strength. The measurements are given as follows in centimetres:

LOWER LIMB.	Right.	Left.	Difference.
From the crest of the ilium to the internal malleolus	65·5	60·	5·5
From the crest of the ilium to the upper edge of patella (femur)	32	29·5	2·5
Length of the foot from the heel to the end of the great toe	22	21	1

[1] *Verhandl. van het Koningl. Nederlandsche Instituut* V. 1852, p. 31, and *Spinal Cord* (New Sydenham Society) p. 110.

UPPER LIMB.			
From the acromion to the styloid process of the radius	41	39	2
Length of the clavicle	11·7	10·6	1·1

The inequality extended to the two sides of the pelvis, chest, and head and face. The circumference of the head just above the ears was 48 cent., of which 25 appertained to the left and 23 to the right side; and the author inferred a corresponding development of the left side of the brain from the fact that hearing with the left ear was much more acute than with the right. (In my case this is not so; and there seems to have been another point of difference in the circumstance that in Broca's boy the left eye was more open than the right, whereas in my case the eye of the larger side is less wide open than the other.) The left side of the tongue was broader, thicker, and rather larger than the right.

Instances of hypertrophy of the fingers on one side, or unequally on both sides, have been noted by Dr Reid, Mr Power, and Mr Curling, see *Med. Ch. Trans.* XXVIII. 338; and it is interesting to observe that Fürbringer (*Knochen und Muskeln der Extremitäten bei den schlangen-ähnlichen Sauriern,* § 13), observes that in the specimen of Pseudopus examined by him, there was a rudiment of the humerus on the right side, but not on the left; and he remarks on a similar inequality in the development of the two sides of the rudiments of the pelvis in Lias and Arbuteas and on the inequality in the lungs of the serpent-like saurians.

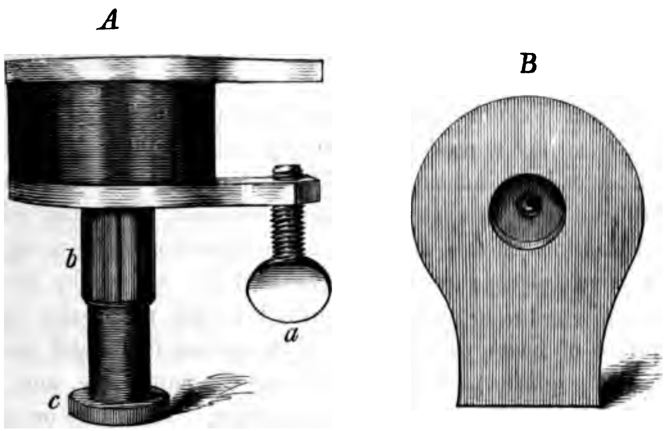
DESCRIPTION OF A SECTION CUTTER FOR MICROSCOPICAL PURPOSES. By A. B. STIRLING, *Assistant Curator of the Anatomical Museum, University, Edinburgh.*

THE section cutter which I am about to describe is an improvement of the old Cutter used by Botanists, and was planned by me in the year 1861, to meet the requirements of my master the late Professor Goodsir, who was at that time engaged in investigating the minute anatomy of the Septum Lucidum of the human brain. He applied to me for sections of the latter, which were at the same time to exhibit its relations to the neighbouring parts, and more especially to the fornix and corpus callosum. In order to accomplish this, I tried several of the cutters used by botanists for making sections of wood, but found none of them adapted for the preparation of such sections as are required by the anatomist. I therefore had a cutter made, such as I am about to describe, and, by an original method of using it, succeeded in preparing sections such as were required at that time, and have continued to use it with perfect satisfaction ever since.

A cutter of the dimensions necessary to the formation of sections so large as those above mentioned, is neither so useful nor so easy of manipulation as one of half the size. But, as the instrument may be made of any dimensions, to suit the views of those using it, I give those of the cutter which I first employed, and may observe that sections larger than such as can be made by its aid are not likely to be required.

The instrument consists of two brass plates cut to the shape of the boards of an ordinary pair of bellows, measuring 7 inches in length by 4 in greatest breadth and $\frac{1}{4}$ of an inch in thickness. In the upper of these plates a hole 2 inches in diameter is drilled. To the inner surface of this aperture a brass tube of an equal diameter having walls of $\frac{1}{3}$d of an inch in thickness and 4 inches in length is fastened by means of hard solder. This tube, which forms what may be called the well of the cutter, is passed through a block of mahogany, two inches thick,

which is cut to the shape of the expanded parts of the brass plates. This allows the narrow ends of the latter, when the instrument is completed, to project beyond the wood, and thus to form a holdfast, by means of which with the help of a pinching screw (*a*) the instrument may be secured to the edge of a table or bench.



Explanation of Figure. A. profile view of section cutter. *a.* pinching screw. *b.* hollow cylinder within which advancing screw works. *c.* milled head of advancing screw. B. surface of cutting platform of upper brass plate. The well is in the centre of the expanded part of the plate. At the bottom of the well is the solid brass cylinder, on which the object to be cut rests.

In the second plate a hole is to be drilled of sufficient size to allow the passage through it of the brass tube, and the plates are then to be secured to the opposite surfaces of the block of wood by means of brass screws passing through them from below upwards. A solid brass cylinder, half an inch in length, is then to be soldered to the lower or projecting extremity of the brass tube. A hole $\frac{3}{8}$ths of an inch in diameter must then be drilled through the long axis of this brass cylinder (*b*), the surface of which hole should be traced with a fine screw-thread. To this hole an advancing screw, 4 inches in length, and furnished with a milled head (*c*) 1 inch in diameter is fitted, and the number of screw-threads should not be fewer than 50 to the inch, whatever the size of the instrument may be.

A solid brass cylinder ¾ths of an inch in length is then adapted with extreme accuracy to the well of the cutter so as to rest on the upper extremity of the advancing screw. The necessity for this cylinder arises from the impossibility without its aid of raising the object to be cut with that uniformity which is essential to the formation of consecutive sections of equal thickness throughout their extent, seeing that, notwithstanding the utmost nicety of the advancing screw, a certain amount of lateral displacement cannot be avoided in the absence of the cylinder described.

The last essential part of the instrument is what may for convenience be named the gouging tube, and consists of a thin brass tube 6 inches in length, and exactly the same bore as the well of the cutter, having a rounded rim adapted to one of the ends to save the hand of the operator while using it.

It is of importance to observe that the screws by means of which the brass plates are united to the mahogany block should be of brass, as otherwise their extremities which pierce the cutting platform will not wear at the same rate, and will thus give rise to inequalities on its surface. The knife or razor used must moreover have a perfectly straight edge from heel to point; if this be not the case the sections will vary in thickness at different points. Having now described the instrument I proceed to give instructions as to the mode of using it.

When the object to be cut is of sufficient size to fill the well of the instrument completely, as in the preparation of sections of such organs as the Brain, Liver, Kidney, &c., a cylinder of the organ, which may previously have been hardened in solution of chromic acid or other fluid, should be cut out by the gouging tube already described. This should then be inserted into the well of the cutter, so as to rest on the brass cylinder which lies in the latter. By means of the advancing screw the object is gradually raised to the level of the cutting platform of the upper plate, when sections of any thickness may be obtained.

In the case of an object of less diameter than that of the well of the cutter, such as a portion of Spinal Cord, the following method is to be employed. The operator provides himself with a fresh and firm, either white or yellow turnip, or large

sound carrot, which is to be carefully washed so as to free it from any particles of sand that may be adhering to it, and which would destroy the edge of the knife or razor used in cutting the sections. From the turnip so prepared a slice of an inch and half in thickness is to be cut transversely with a thin-bladed knife, and by means of the gouging instrument a cylinder is to be punched out of it. The operator should then select from a set of ordinary cork-borers, which he ought also to be provided with, one with a diameter slightly less than that of the cord, and bore with it a hole through the long axis of the turnip cylinder.

The latter is then to be longitudinally bisected. Then put the portion of cord in the groove of the one half of the turnip, and replace the other half so that the cord may be included between them, after which the whole are to be placed in the well of the instrument. Those directions apply equally to the formation of transverse and longitudinal sections of the cord, with this difference, that in the latter the hole is bored through the turnip cylinder transversely instead of longitudinally. After being placed in the cutter the entire mass is elevated to the requisite level and the sections cut; the knife or razor of the operator being moistened with spirit before each cut is made. The section is then selected and placed in spirit by means of a camel-hair pencil, while the slices of turnip are rejected. In making the section the knife or razor is laid flat on the surface of the cutting platform with its edge directed away from the operator, and the cut is to be made from right to left of himself. By attending to the directions given above any one will succeed in making perfect sections at the first attempt from properly prepared cords, and in a short time will be able to do so at the rate of hundreds an hour. As an illustration of the precision with which the instrument may be employed I may state that I can cut as many as 300 transverse sections from an inch of spinal cord. I have tried many media for fixing the object to be cut in the well of the cutter, namely paraffine, gelatine, wax, cheese, pith, fine or velvet cork, and several kinds of roots with varying success; but I prefer the turnip and carrot to all others. Swedish turnips and potatoes are to be avoided,

for the starch they contain is difficult to be got rid of, and the object in consequence is spoiled.

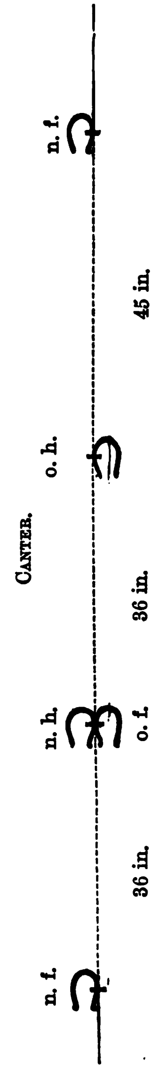
The great point to be attended to in preparing sections by means of this instrument is to have the object to be cut properly adjusted in the turnip cylinder, and this with many objects can only be accomplished by means of practice and a little ingenuity. It is impossible to lay down absolute rules for guidance, but if attention be paid to the principle detailed above no difficulty ought to be experienced.

I have myself no difficulty in adjusting and cutting objects from the size of a hair to that of an embryo an inch and a half in length by means of this cutter. I can slice such an embryo into from seventy to eighty sections in the long direction, each of microscopic thinness without loss of the minutest portion, so that the entire organism can be examined in all its parts. My preparations are now in the hands of many anatomical teachers both at home and abroad.

The instrument is manufactured by Messrs Parkes, Opticians, 5, St. Mary's Row, Birmingham, from whom it can be obtained at a moderate price.

THE ACTION OF THE HORSE. By JOSEPH GAMGEE, Sen. *Edinburgh.*

MY paper on this subject in the *Journal of Anatomy and Physiology* for last May, has fulfilled one of its objects, that of attracting attention to an important question in animal locomotion, much obscured by imperfect observation and servile repetition of errors.



I am not quite certain that the criticism with which Mr Neville Goodman has honoured me is not another proof, to quote his own words, of "how far mere compilation has taken the place of thoughtful digestion in the writers of the present day." I only wrote after very thoughtful digestion, of numerous observations; and on very carefully reading over my paper of last May, I cannot find a sentence that requires altering.

In his concluding paragraph Mr Goodman refers to *the horse* from which I took my measurements. My conclusions are based on observations and accurate measurements of the paces not of one horse, but of many hundreds of horses. I cannot but think that when Mr Goodman has gone through a similar process of observation, he will discover the error of his statement that "there is no essential difference between the canter, gallop, and racing pace." The canter of the horse, with the amble and some of the paces brought out in the riding-school, differs as much from walking, trotting, and galloping, as dancing does from walking and running in man. The canter has the special object of poising the weight—carrying it easily — alike for the rider and the animal. If a small pony has to carry a big man at a pace faster than the walk, he readily adopts the canter, but takes to the gallop if a boy be put up instead of the heavy weight. Newmarket Heath is not far from Cambridge, and the strings

of horses in training there will offer Mr Neville Goodman abundant opportunity for judging of the essential characteristics of the gallop. Before mentioning the peculiar characteristics of the canter, I must warn observers against being misled by the technicalities of racing phraseology, that which racing men call a canter being no canter at all, but a slow gallop. The terms gentle canter, brisk canter, slow gallop, half and three-quarters gallop, full speed, &c., which are expressions perfectly understood and constantly used by trainers and the lads acting under their direction, in reality merely indicate variations of one pace, the gallop. The characteristic of the canter, which distinguishes it from all other paces, is the parallel position of the leading fore and its diagonal hind foot at every third step, as is shewn in the annexed diagram. Again, the stride is less in the canter than in the trot even. If after repeating the observations on which my conclusions are based, Mr Goodman can point out any errors of fact, I shall be glad to go over the ground again. For the present, however, I must hold to the strict accuracy of my paper published in this Journal last May.

NOTE ON UNUSUAL ACCESSORY MUSCLES.

By Lawson Tait.

Last summer I had in my dissecting-room a male subject, aged 82, who had died from suicidal cut-throat, and who in youth must have possessed great muscular development. The ridges for muscular insertion were all strongly marked, and he had on the right side the following unusual accessory muscles.

I. A very well-marked instance of Wood's supra-costal muscle (Rectus Thoracis of Turner), consisting of a series of musculo-tendinous slips arising from the transverse processes of the upper six cervical vertebræ. These united into a mass and passed downwards about an inch from the outer edge of the scalenus anticus, and reached as far as the upper margin of the

fourth rib. The muscle was attached by well-marked tendons into the upper margins of the first and fourth ribs, and into the lower margins of the second and third. Behind it lay the scalenus medius which was, together with the scalenus posticus, normally attached.

II. A sterno-clavicularis which consisted of a long slender muscle passing obliquely upwards and outwards to the shoulder. It arose by two distinct heads, one at the junction of the cartilage of the first rib with the manubrium (posterior aspect), the other from the posterior edge of the rib about an inch external to the origin of its fellow. The muscle lay first on the brachio-cephalic trunk, the lower thyroid vein curving round in front of it. It lay next on the scalenus anticus where it had a central tendon; it then crossed obliquely over the subclavian artery and the trunks of the brachial plexus, and lay on the supra-costal muscle already described. The Omohyoid curved round it from above downwards and backwards, and was inserted into the scapula as usual. Where the Omohyoid was in relation to it, the accessory muscle had another central tendon, and was therefore a trigastric muscle. It was inserted into the clavicle just at the inner margin of the insertion of the trapezius. On this side the thyroid axis arose from the subclavian an inch to the inner side of the scalenus anticus, and gave off the inferior thyroid, cervicalis ascendens, and transversalis colli. The supra-scapular was given off as a separate trunk behind the scalenus anticus. The subclavian muscle had its ordinary relations.

III. An accessory stylo-hyoid consisting of a slender bundle of fibres arising close to the base of the styloid process on its inner aspect, and being attached to the outer surface of the great cornu at the juncture of the outer with the middle third. The muscle passed downwards parallel and close to the stylo-hyoid and the posterior belly of the digastric (both of which had their normal relations) but on a plane rather external and posterior. From these two muscles it was separated by the occipital artery and the stylo-hyoid ligament. It crossed the hypoglossal nerve, the external carotid and lingual arteries, and in the upper part of its course was in close relation to the internal

carotid artery. Its tendon of origin crossed the pneumogastric nerve.

As I had neither time nor opportunity to make the necessary references to similar anomalies already published, I submitted my notes to that distinguished myologist, Professor Macalister of Dublin, from whose letter to me I make the following extracts. "A sterno-clavicularis is described by Prof. Luschka of Tubingen in Müller's *Archives* for 1856, p. 282, Taf. 10, but this went in front of the cleido-mastoid. Haller has also described a muscle of this kind, as also has Weber, the former of these authors regarding it as an accessory subclavius; the latter as a differentiated slip of the triangularis sterni, and I found an instance of Luschka's muscle on one side in a subject, noticed in *Pro. R. I. Acad.*, Dec. 1867. A second stylohyoid I once saw during the session 1868—9, but never have published it; nor, as far as I recollect, has a case of it been published. The stylo-glossus has been found double by Meckel, and the stylo-pharyngeus by Böhmer.

"The supra-costalis in the examples published by Mr Wood have mainly a costal insertion; but in an instance published by me (Apr. 23, 1866, *Proc. R. I. A.*), this muscle arose from the four upper ribs, crossed the first rib, and was inserted into the cervical fascia in the posterior inferior triangle of the neck. Your case is but an extension upwards, and a more perfect development of this. It is always separate from the scalenus in man, and I think can claim no affinity with the rectus sternalis."

Prof. Cleland has also given me some valuable information which I abstain from using, lest I give this note a value which it does not deserve. I am content to put on record the occurrence of a hitherto undescribed variety of an accessory muscle, and the occurrence of two muscles, both of which may be said to be in most respects quite new.

ON THE CORRESPONDENCE BETWEEN THE PARTS COMPOSING THE SHOULDER AND THE PELVIC GIRDLE OF THE MAMMALIA[1]. By W. H. FLOWER, F.R.S., F.R.C.S., *Hunterian Professor of Comparative Anatomy at the Royal College of Surgeons of England.*

I DO not propose to give any account of the literature of this much vexed question, as the recent papers of Mr Mivart[2] and Professor Rolleston[3] contain ample references to all that has been written relating to it; my intention at present is only to give a concise statement of views which an independent study of the subject has led me to adopt, and which I shall be glad to see thoroughly tested by other anatomists working in the same field.

The correspondence between the bones (to which I have mainly addressed myself) here suggested is closer than at one time I had expected to find it; but as the bones form the solid framework around which the other structures are disposed, it is in them that homologies are most likely to be traced. The muscles, undoubtedly, offer a general correspondence also; but as is well known, they are very variable even in one single species (as *Homo*, where alone the variations of the muscular system have been studied), and most unstable in passing from one species to another, evidently adapting themselves, as it were, to the points of attachment afforded them, although they may also influence in their turn the osseous substructure. The nerves will probably help, when thoroughly worked out, to throw light on the homologies of the muscles, although at present but little has been done in this direction. The mode of vascular supply is far too shifting and adaptive ever to be of much assistance in these enquiries.

Numerous and conflicting as are the theories which have

[1] The substance of this communication formed part of a lecture delivered at the Royal College of Surgeons of England, on the 26th of last March.

[2] On some points in the Anatomy of Echidna hystrix, *Linn. Soc. Trans.* xxv. 1866.

[3] On the homologies of certain muscles connected with the shoulder-joint, *Ibid.* xxvi. 1869.

been, and still are maintained by anatomists of eminence regarding the corresponding bones of the upper and lower extremities, I cannot see that since the idea of comparing the limbs together in their primitive developmental condition, suggested by Professor Humphry[1], and fully carried out by Professor Huxley in his Hunterian Lectures for 1864[2], there is room for any more doubt or disagreement on the subject. I shall therefore take it for granted that the limbs being extended at right angles to the axis of the trunk and parallel to each other, there is a superior or dorsal surface, an inferior or ventral surface, and an anterior and a posterior edge. These last are called by Professor Huxley *preaxial* and *postaxial* (in reference to the axis of the limb itself), to avoid the confusion with *anterior* and *posterior* in the modified positions they assume in Man and various animals.

The dorsal surface of the anterior extremity corresponds with the back of the hand and the extensor surface of the forearm and arm. The dorsal surface of the posterior extremity, with the dorsum of the foot, front of the leg, and the extensor surface of the thigh. The preaxial line of the anterior extremity has in it the thumb, the radius, the outer condyle, and the great tuberosity of the humerus. The preaxial line of the posterior extremity has the great toe, the tibia, and the inner condyle and lesser trochanter of the femur. All these parts then should be regarded as serially homologous[3].

The difficulty arises, on passing upwards to the shoulder and pelvic girdles, and this difficulty results solely, I think, from not applying the same principles to them, which, when

[1] *Observations on the Limbs of Vertebrated Animals*, 1860, p. 16.

[2] *Med. Times and Gazette*, Feb. 1864.

[3] Professor Jeffries Wyman has grounded an investigation into this subject on the idea of a "fore and hind symmetry," which has led to conclusions exactly opposite to those stated above (On Symmetry and Homology in Limbs, *Proc. Boston Soc. Nat. Hist.*, June, 1867). Notwithstanding my respect for the opinion of so distinguished an anatomist it appears to me perfectly evident that the key to the true homologies, here as in other parts of the body which are serial repetitions of each other, *e.g.* the vertebræ, is to be found in the anterior or cephalic aspect of the one corresponding with the same aspect of the other, in their primitive position, and that all deviations from this position, as the apparent reverse flexures of the anterior and posterior extremities instead of indicating an antero-posterior symmetry as part of the original plan of construction are only adaptations to the actions required from the parts in question in fulfilling their functions in the economy of the fully developed animal.

applied to the other segments of the limb, have given such a clear demonstration of their correspondence.

Assuming the general homologies of the scapula with the ilium, and the coracoid with the ischium, or ischium and pubis, it has been too often taken for granted that these are flat bones having an outer and an inner surface, and that the outer surface of the one must correspond with the outer surface of the other. This view causes great difficulties with the muscular attachments, as the muscles inserted into the preaxial (or greater) tuberosity of the humerus, arise from the outer surface of the scapula, while the muscles inserted into the preaxial (lesser) trochanter of the femur arise from the inner surface of the ilium. Thus Professor Rolleston speaks of the homology of the *subscapularis* and *teres major* with the middle and smallest *glutei*, muscles inserted into corresponding points, and having a corresponding nervous supply, as an "apparent paradox" and a "stumbling-block" on account of their respective origins from the scapula and ilium. Now I think that I shall be able to shew that these muscles agree in their origin as closely as in their insertion[1].

In every mammal both scapula and ilium may be resolved into a bar or rod of three-sided or prismatic form.

The two extremities of the bar are placed, as regards the general position of the trunk, dorsally and ventrally.

The dorsal or upper extremity is capped by the supra-scapular epiphysis in the shoulder girdle, and by the corresponding supra-iliac epiphysis in the pelvic girdle.

The ventral or inferior extremity enters into the formation of the glenoid or the cotyloid articular cavity, as the case may be, and joins with the *coracoid* or the *ischial* element of the girdle.

The bar, supposed to be in a nearly vertical position, has three surfaces and three borders.

In what may be, at least theoretically, considered their primary position, the surfaces of each bar are—1. Inner or vertebral, turned towards the vertebral column; 2. Anterior or

[1] I must add in justice to Mr Mivart, that in his paper quoted above, he suggests precisely the view that I have since developed quite independently, and also that the idea of carrying out the principle already applied to the rest of the limb to these bones, may be found in Prof. Humphry's paper, although not worked out into definite results.

preaxial, corresponding to the preaxial line of the limb; 3. Posterior or postaxial, corresponding to the postaxial line of the limb.

The borders are—1. External, corresponding to the superior, outer or extensor surface of the proximal long bone of the limb; 2. Antero-internal; 3. Postero-internal. The first border terminates below at the upper margin of the glenoid or cotyloid cavity. The second terminates below in the acromion, or in the pubis. The third terminates below in the coracoid, or the ischium, as the case may be.

The correspondence between the ideal scapula and the human scapula, and the ideal pelvis and the human pelvis, and consequently between the human scapula and the human pelvis, gives the following result:

SURFACES.

Scapula.	*Ideal.*	*Pelvis.*
Supra-spinous fossa.	1. Vertebral.	Inner surface of ilium behind *linea arcuata interna*, including the articular surface for the sacrum, and the portion of the bone above and below this.
Infra-spinous fossa.	2. Preaxial.	Internal iliac fossa.
Subscapular fossa.	3. Postaxial.	Gluteal surface of ilium.

BORDERS.

Axillary border, posterior in most animals (attachment of *triceps* muscle).	1. External.	Anterior border (attachment of *rectus* muscle).
Spine, continued into acromion.	2. Antero-internal.	Linea arcuata interna continued into pubis.
Superior border, anterior in most animals, with scapulo-coracoid notch.	3. Postero-internal.	Posterior border with ilio-ischiatic notch.

We thus see that the four principal muscles or groups of muscles disposed around the shoulder and hip-joint correspond in their origin and attachment, the extensors (*triceps* and *rectus*) arising from border No. 1 in both; the flexors, *biceps*, and *coraco-brachialis* in the upper, *biceps*, *semi-membranosus* and *semi-tendinosus* of the lower, arising from the coracoid and the ischium respectively, at the lower end of border 3. The preaxial muscle of the anterior extremity, *infra-spinatus*[1], corresponding with the preaxial muscle, *iliacus*, of the lower; and the postaxial muscle of the one, *sub-scapularis*, with the postaxial muscles of the other, *gluteus medius* and *minimus*.

As the humerus in ordinary quadrupedal mammals is rotated backwards from its primitive position, and the femur is rotated forwards, so that the preaxial side of the first becomes external, and the really corresponding side of the other becomes internal, so it is with the scapula and ilium. Each has undergone a half, or nearly half rotation in its long axis, and in the opposite direction, so that the inner surface of the one comes to correspond with the outer surface of the other, the anterior border of the one with the posterior border of the other. The long axis of each is also differently inclined, which makes the resemblance at first sight more obscure, the upper end of the scapula leaning backwards, while that of the ilium is turned forwards.

Some exception may perhaps be taken to the correspondence between the acromion and the pubis (although when the former is joined to the coracoid by the coraco-acromial ligament, or by bone, as in the sloths, the resemblance is very striking, a complete "obturator" foramen being formed), and I do not wish to press this point too far, especially as many good authorities consider the latter as the serial homologue of the *præcoracoid* of the inferior vertebrates. But this term "præcoracoid" is sometimes applied to a process from the coracoid, as in lizards, sometimes to an independent ossification, as in frogs, and sometimes to a process from the scapula, quite comparable to the mammalia acromion, as in the Chelonia[2]. If re-

[1] The *supra-spinatus* is probably but a dismemberment of this.

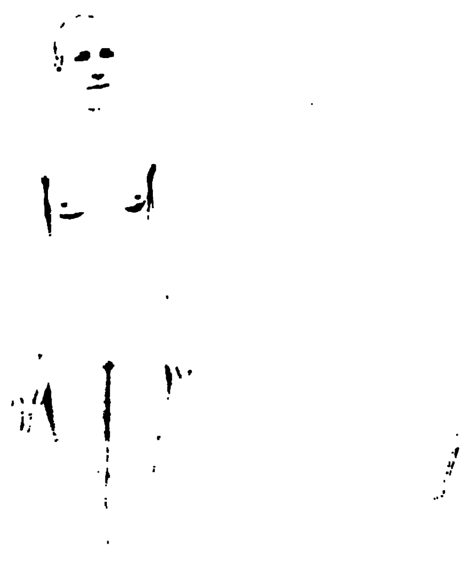
[2] See Parker *On the Structure and Development of the Shoulder-girdle and the Sternum in the Vertebrata*, 1868.

lation to surrounding parts and not mode of development is the test of homologies, the acromion of the mammal may correspond to one or all of the anterior bars of the shoulder girdle of the inferior vertebrates, and then all difficulty about its serial homology with the pubis would be removed. I should mention also that the muscular attachments fit in with this view, as Professor Rolleston has already, on other grounds, decided that the deltoid of the upper extremity finds its nearest homologue in the pectineus of the lower, and the one has its chief origin from the acromion, the other from the pubis.

The principal differences between the shoulder and pelvic girdle of the mammalia are two—1. The rudimentary condition of the inferior or ventral section of the girdle (the coracoid) in the former, as compared with the vast development of the corresponding part of the lower extremity. This must necessarily cause a great discordance in the nature and arrangement of the muscles mainly attached to this part. 2. The free condition of the anterior as compared with the posterior girdle. It is neither attached to the vertebral column above, nor does it (except in the *Monotremata*) join the opposite part in the middle line below. To compensate for this a clavicle is superadded to the anterior girdle in many mammals, for the homologue of which in the lower extremity we look in vain.

The ilia are retained most nearly in what I have considered their primitive condition of equally trihedral or prismatic rods in the Monotremata, especially *Echidna*. This condition is also well seen in nearly all Marsupials, especially *Didelphys*, and in most Rodentia. The extent of the different surfaces and their directions vary much in other mammals. Thus the iliac surface, so large in man, gradually diminishes in the monkeys, being encroached upon by the vertebral surface, and is almost obsolete in the Carnivora. In the armadillos and hare the iliac and the gluteal surfaces (nearly parallel and opposite in Man) are almost in the same plane.

The directions and relative extent of the scapular surfaces vary also. In the Cetacea, what may be considered as the primitive prismatic form is flattened, so that surfaces 2 and 3 (see p. 241) are nearly parallel and equal, and surface 1 is almost obsolete, borders 2 and 3 being closely approximated; while in the



Echidna the flattening has taken place in exactly the opposite direction. Surface 1 is immensely extended, and surfaces 2 and 3 almost form one plane, opposite and parallel to 1, border 1 forming scarcely any prominence, and borders 2 and 3 being widely separated, so that the tendency to a three-sided form, so constant in all mammals, though susceptible of such great modifications, is scarcely apparent in this low type, which thus offers an approximation to the inferior vertebrata.

NOTE OF A CASE OF ABNORMAL UNION OF SEVERAL OF THE RIBS. By JOHN A. CAMPBELL, M.D. *Assistant Medical Superintendent of the Cumberland and Westmorland Asylum, near Carlisle.* (Pl. XI.)

AT a post-mortem examination on Feb. 15, 1870, of a patient whose death resulted from disease of the brain, we found the following peculiar abnormalities of the ribs. On the left side, the first and second ribs were united at a spot an inch distant from the sternum by a transverse piece of cartilage half an inch in breadth.

The sixth and seventh ribs were united by a transverse piece of bone one and a half inch in breadth, at a point five and a half inches from the junction of the ribs with their cartilages. On the lower edge of the sixth rib, close to its cartilage, there was a small exostosis projecting downwards and forwards to the seventh rib. The eighth rib had a spike-shaped exostosis taking origin from the bone close to its junction with the cartilage and projecting upwards and forwards, and on its lower edge a shorter and blunter exostosis rising half an inch from the end of the rib. The ninth rib had on its upper edge, quite close to its cartilage, a spike-shaped exostosis one quarter of an inch in length. The ninth and tenth ribs were united, one quarter of an inch from their cartilages, by a piece of bone one and one half inch broad. The tenth rib at its junction with its cartilage had a small exostosis projecting downwards.

On the right side the first and second ribs were united by a transverse bar of bone, one inch and a half broad, at a spot two inches from their junction with their cartilages. The outer surface of this transverse bar was thickened and raised slightly above the level of the rest of the ribs. On its under surface it was also raised; and at the posterior part of its origin from the first rib there was a raised knob the size of a split horse-bean. Half an inch from the junction of the second rib with its cartilage there was a spur-shaped exostosis rising from the lower edge of that rib. The fourth and fifth ribs were firmly united by bony union three inches from their cartilages, the bar of bone that joined them being an inch broad. The seventh rib had an exostosis on its upper and on its lower edge a quarter of an inch from its cartilage.

With the exception of the transverse bar uniting the first and second ribs of the right side, the attachments, whether by bone or cartilage, were less prominent than the level of the surfaces of the ribs, and smooth externally and internally; and they just seemed to be growing out of the contiguous edges. There were no bony growths about the skull, but in the substance of the diaphragm there was a cartilaginous plate five inches by three, ossified in the centre; and there was a small cartilaginous plate about the size of a halfpenny in the substance of the right lung.

DESCRIPTION OF PLATE XI.

Left Side.

- *a.* Cartilaginous junction of 1st and 2nd ribs.
- *b.* Osseous junction of 6th and 7th ribs.
- *c.* Exostosis on lower edge of 6th rib.
- *d* and *e.* Exostosis on upper and lower edges of 8th rib.
- *f.* Osseous junction of 9th and 10th ribs.
- *g.* Exostosis from under surface of 10th rib.
- *h.* „ „ upper surface of 9th rib.

Right Side.

- *i.* Osseous junction of 1st and 2nd ribs.
- *j.* Spur-shaped exostosis from lower edge of 2nd rib.
- *k.* Osseous junction of 4th and 5th ribs.

DESCRIPTION OF A FŒTAL BRAIN. By GEORGE W. CALLENDER, *Assistant Surgeon to, and Lecturer on Anatomy at, St. Bartholomew's Hospital.*

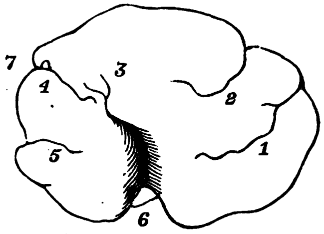
PART I.

IN describing the brain of a fœtus of fourteen weeks references to earlier steps in the process of development are necessarily introduced. Upon some of these steps anatomists are agreed, but there are many yet in doubt, and some have been entirely overlooked. Having examined twenty-three fœtal brains in various stages of development, from the third week to the sixth month of intra-uterine life[1], I shall venture on certain suggestions respecting the plan on which this development proceeds.

In the specimen before me (fœtus of fourteen weeks) the length of the brain from the most anterior border to the posterior surface of the corpora quadrigemina is ·9 of an inch; the extreme breadth is ·8 of an inch; the length of each hemisphere is ·7 of an inch.

The outer surface of each hemisphere (Fig. I.) is marked from before backwards with five chief depressions. The first (1), reckoned from the front, and the second (2) are mere fissures.

Fig. I.

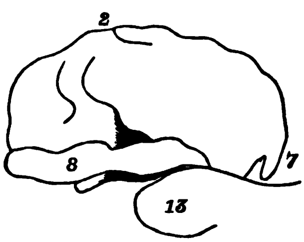


[1] I have arranged a table shewing in twenty instances, as far as is practicable, the age of each fœtus in correspondence with its length. See *Phil. Trans.* 1869, p. 163. The length of the fœtus in the specimen here described is 3·4 inches, and of the remaining two which complete the series it is 1·1 and 2·2 inches. Corresponding measurements are given or quoted by Ecker, but they differ very considerably from my own. See *Archiv für Anthropologie,* 1869.

The third (3) is a broad, nearly vertical groove, narrowing to a fissure above, and is continued, with a short offshoot, nearly horizontally backwards at 7. It divides the hemisphere into a well-marked anterior and posterior lobe. At the base of this groove a band of nerve tissue crosses with a slight curve, the convexity of which is downwards (6). The fourth (4) and fifth (5) fissures mark off the hinder part of the hemisphere into two nearly equal portions[1].

On separating the two hemispheres the inner surface of each is seen to be marked at its lower border by a prominent ridge (Fig. II. 8). This, as traced from the front, ends posteriorly by sloping to a point above the middle of the optic thalamus (13). About the centre of this ridge is a considerable

Fig. II.



depression ascending forwards, and above this is the end of the second fissure (2) of the outer surface. Posteriorly a notch (7) marks the end of the brain tissue above the fissure 3.

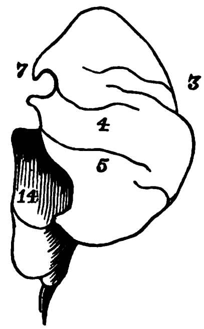
On the posterior surface of the hemisphere the third (3), fourth (4), and fifth (5) fissures are in view (Fig. III.), and the two last reach to the side of the corpora quadrigemina, but the tissue of the hemisphere does not overlay that portion of the brain.

Of the marks thus far referred to number 6, Fig. I. is the under surface of the corpus striatum. Fissure 1 corresponds somewhat to one of the anterior frontal fissures of the adult brain (anterior Sylvian of Gratiolet); fissure 2 to that of

[1] In Fig. I. the depth of the hemisphere is exaggerated, as a portion of the base is introduced to shew the mass of brain tissue fitting into the notch at the lower extremity of the third fissure. In this and in the following figures similar numbers indicate similar parts.

Rolando; fissure 3 to that of Sylvius, and 4 completes the separation of the anterior from the posterior lobe of the hemi-

Fig. III.



sphere. Fissure 5 represents the occipito-temporal. The several fissures may be conveniently named (1) the frontal, (2) the post frontal, (3) the parietal, (4) the occipital, (5) the temporal. Between these fissures the hemisphere is divided into five regions, (1) frontal, (2) post frontal, (3) parietal, (4) occipital, (5) temporal. The under surface of the corpus striatum corresponds with the island of Reil[1].

These lobes or primary convolutions do not correspond with the first thickening or ingrowth of the wall of the lateral ventricle (with the exception of the corpus striatum). They represent the thin parts of the wall. The primary ingrowths of the hemisphere follow the course of the several fissures (Fig. IV. 1, 2, 3, 4, 5).

The fourth and fifth lobes are developed downwards and forwards, turning fan-like upon the corpus striatum, Fig. I. 6, as upon a pivot, to acquire the positions they occupy in the adult.

Figure IV. represents the parts seen on a section of the brain made after this fashion. The primary vesicles are cut through vertically in the middle (antero-posterior) line. The entire inner wall of the hemisphere (right) is removed so as to

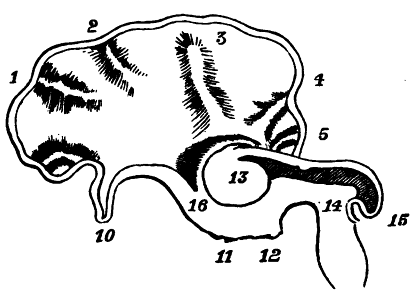
[1] I am unable to agree with Tiedemann, who states that the calcarine sulcus is one of the first to appear, and that it is first seen about the fifteenth week of fœtal life.

bring into view the inner surface of the outer wall (shewn in Fig. I.) and the cavity contained within the hemisphere (lateral ventricle).

With this figure as a guide I propose to consider the arrangement and the development of the several parts of the encephalon which are formed out of the three primary vesicles at the anterior extremity of the cerebro-spinal axis.

The formation of these vesicles from two lateral portions, or rather in the form of a crescent open posteriorly, is apparent in the fourteenth week, as there is no union between the horns of the crescent from the medulla oblongata forwards on the upper (posterior) surface, and the central canal is open to its superior extremity (my observations are limited to the structures above the spinal cord).

Fig. IV.



The second (middle) vesicle, Fig. IV. 14, at the fourteenth week consists of a mass of tissue (anterior columns) which fills up its lower half (at least), and already indicates the elevations known as the nates and testes which thus appear in the centre of this vesicle before they become prominent on the surface. They are placed at the bend formed between the first and third vesicles.

Above the anterior columns is the central canal, wider behind than in front, and above this again is a layer of tissue (posterior tracts), slight by comparison with the columns, overlying the central canal. They are divided by the posterior fissure which opens into the canal, and each is prolonged laterally into the layer of tissue which connects them with the columns. The posterior fissure is closed at the front part of

the second vesicle and forms the posterior white commisure of the third ventricle in the adult. Fig. IV. below 5. The second (middle vesicle) consists, therefore, at the fourteenth week of the thick anterior columns, united mesially, of the posterior tracts, united only by the white commisure, of the lateral masses, which for my present purpose will be considered with the anterior columns, and of the central canal (passage from the third to the fourth ventricle, Sylvian Aqueduct), which is open above in the whole of its length, except where the tracts are joined at the commisure.

The changes in the first (anterior) vesicle are more complicated.

The vesicle is at first a dilatation of the crescent-like cerebro-spinal axis, and is open posteriorly like the second vesicle and also in front, Fig. V. 19. About the seventh week it is bent downwards nearly at a right angle to the second vesicle, and this bend remains at the fourteenth week so far as the lower portion of the vesicle is concerned. This flexure corresponds with the end of the notochord, and, throughout the development of the brain, remains as a fixed point about which various changes are effected.

The changes which ensue in the anterior vesicle are connected (*a*) with the advance of the posterior tracts of nerve substance from the second vesicle, (*b*) with that of the anterior columns. Fig. IV. 14. (*a*) The upper portion of the anterior vesicle on each side of the median fissure becomes thickened in direct continuity with tissue about the region of the posterior white commisure (Fig. IV. 5), and about the ninth week this thickened tissue has curved upon itself, making a deep fissure in the anterior wall of the vesicle, and in the twelfth week, by filling up of the space with the curve, has formed the rounded mass (Fig. IV. 13) known as the optic thalamus. Thus the optic thalamus of either side is the termination of the corresponding posterior tract of the second vesicle, curved upon itself, and forming the *anterior terminal flexure* of the posterior tract.

At the bend of the flexure thus formed the true central canal ends, and the posterior fissure, prolonged to the anterior

extremity of the flexure, ultimately forms the third ventricle. At the fourteenth week this fissure is open in front, whilst behind it is continuous with the central canal in the middle vesicle. A slight elevation above the commisure marks (at the fourteenth week) the site of the pineal gland, and the ridges from this, the crura of the gland, are distinctly formed.

(*b*) Whilst the cartilage at the base of the skull grows forward, surrounding and forming the pituitary fossa, throwing out lateral portions in which the alæ of the sphenoid are developed, and extending to the very front of the face-skull to end in the tissue in which the intermaxillary bones are ossified, the growth of the anterior columns corresponds with that of this supporting and protecting cartilage base.

Tracing the growth of the right-side column, Fig. IV. 16, a mass of tissue rather over ·1 of an inch in thickness, at the fourteenth week, passes forward closely applied to the under surface of the optic thalamus. Unlike the columns which are united in the middle vesicle, the two which grow forward from the first vesicle are separate and slightly divergent. In the posterior part of each (above, 12, Fig. IV.) the crus cerebri has its origin, in front of this is formed the corpus striatum, and as each column grows forward it unites with its fellow and constitutes the corpus callosum (at 16, Fig. IV.). Behind the corpus callosum, in the middle line, will be found the lamina cinerea and the tuber cinereum, but these structures require separate notice.

The anterior column of either side (with which is included the whole thickened tissue of the vesicle below the level of the central canal) after reaching the curved anterior extremity of the optic thalamus, and growing with its incurvation, turns its superior surface over the thalamus and continues its inferior in correspondence with the trabeculæ cranii (of Rathke), developes the olfactory tract and bulb (Fig. IV. 10), and then rises to constitute the hemisphere (mantle) in which a fan-shaped cavity is developed, prolonged below into the olfactory tract. This cavity is the lateral ventricle, and thus far (fourteenth week) has no communication with the cavity of the third ventricle.

The hemisphere (mantle of Reichart) is thus formed from

the anterior column supplemented by some part of the lateral tissue of the first and second vesicles. The hemisphere is therefore the *anterior terminal flexure* of the anterior column. Whilst the posterior tract is bent down, the anterior is turned up and is expanded over the posterior from before backwards. At the fourteenth week it overlays the entire optic thalamus, but scarcely reaches the corpora quadrigemina.

It is generally stated that the convolutions do not appear before the fourth month, but in Fig. IV. six distinct ingrowths of brain tissue separate and define the primary convolutions. These ingrowths correspond in position with the fissures observed on the surface, the most prominent ridge agreeing with what I have termed the parietal fissure (3), and these ridges, which diverge fanlike from the corpus striatum, are not merely inflections of brain tissue, but are formed by great thickening of the inner layer of the hemisphere behind the fissures, and are the primary ingrowths upon the cavity of the lateral ventricle. They are numbered in Fig. IV. as are the fissures in Fig. I., but there is an additional ridge drawn in Fig. IV. which corresponds with the inferior margin of the frontal portion of the hemisphere[1].

Supposing the mantle, or hemisphere, to be developed from the anterior column, these ingrowths from the walls indicate the extreme complexity of arrangement which must be looked for in the adult brain.

The growth of the corpus striatum takes place in the lower part of the hemisphere, below the optic thalamus and to its outer side. Whilst the optic thalamus is yet forming, the anterior column, expanding, forms from the eighth to the twelfth

[1] My observations lead me to dissent from the views of Ecker respecting the formation of the primary sulci and convolutions. I have never seen such appearances as are figured in the drawings which illustrate his paper, and I quite disagree with the statement to the effect that, between the brains of various specimens, including twins, there appear great differences in the disposition of the first sulci, or furrows, not only with reference to the time of their appearance, but also with regard to their form and direction. In all the specimens I have examined, the furrows marking the primary sulci have been remarkable for their regular disposition. In a fœtus of fourteen weeks as many as fourteen secondary sulci may be counted between fissures 2 and 3, but they are irregular and variously branched. I agree with Ecker that there is no evidence that the left hemisphere is in its development in advance of the right (as suggested by Gratiolet); see A. Ecker, *Archiv für Anthropologie*, 1869, p. 221.

week a thick mass around it. As this increases, by projecting at the base, the first prominent mass on the surface of the brain is formed (island of Reil, or corpus striatum lobe), and growing up by the side of the thalamus is separated from it, at the fourteenth week, by a deep fissure. This fissure is subsequently obliterated by the union of the opposed surfaces of the corpus striatum and optic thalamus. The narrow band of the mantle left on the optic thalamus becomes the fornix, and beneath this a communication is established between the lateral and the third ventricles.

The accompanying table indicates the relations between the first and second cerebral vesicles and the parts developed from them.

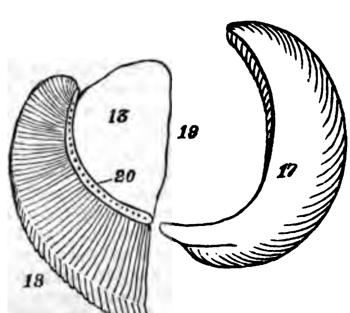
Middle vesicle ... Posterior tracts.
Posterior commisure.
Aqueduct of Sylvius.
Anterior columns.

Anterior vesicle...crura of Pineal gland.
anterior flexure
(left and right).
{optic thalami.
optic lobes.
third ventricle.}

crura cerebri.
corpus callosum.
anterior flexure
(left and right).
{hemispheres or mantles.
lateral ventricles.
olfactory lobes.
Fornix.
corpora striata.}

The wall of each mantle is easily separated into three layers, and, as has been already named, it is from thickening of the inner of the three (which lines the ventricle) that the primary ingrowths arise. In Fig. V., 13 represents the anterior surface

Fig. V.



of the optic thalamus. Below this surface the inner wall of the mantle has been removed to shew the middle layer in which the fibres are seen coming out from the anterior columns; first those which ascend to form the inner wall of the hemisphere (these are represented at 20 as cut short in the diagram); secondly, those which form its base and its outer wall, the latter being figured at 18 radiating to the fore and back parts of the mantle. At 17, on the opposite side, the thick mass of the inner wall is figured, curving round the optic thalamus and overlying the fibres spreading as at 18 into the hemisphere, and this mass represents the upper portion of the corpus striatum.

At this period of development, therefore, the optic thalami are distinct terminal structures. The anterior columns spread out their fibres from beneath and around the thalami. Those fibres enclose the lateral ventricles, forming a series of circles in either mantle fashioned after the shape of the hemisphere wall. The primary sulci mark the lines in which the inner coat of the mantle thickens and grows upon the cavity of the corresponding ventricle, but their origin and that of the convolutions must be sought in the earlier changes which are connected with the outgrowth of the anterior columns as they are seen in a fœtus of about the 9—10 week.

NOTICE OF TRUE HERMAPHRODISM IN THE COD-FISH (*Morrhua vulgaris*), AND IN THE HERRING (*Clupea harengus*). By JOHN ALEXANDER SMITH, M.D., *Edinburgh*[1].

THE cod-fish, the genital organs of which I shall describe, was taken off Anstruther in the Firth of Forth on the 17th March, 1870; it was well developed, and in good condition, no other peculiarity of structure being observed.

The two lobes of the ovary or roe are well formed and nearly equal in size, they measure each about nine inches in length, by rather more than three inches in greatest breadth, and are full of distinctly formed ova. There is however attached to the upper extremity of the right lobe of the ovary, a convoluted many-lobed mass of testicle or milt measuring about three inches in length, and two and a half inches in greatest breadth, arranged round a central broad ligament-like portion of membrane (the mesorchium of Prof. Owen), which is about half an inch in breadth where it is attached to the ovary. This membrane appears to be simply a continuation of the fibrous covering of the ovary itself. No openings however could be detected, through the portion of membrane which attached it to the ovary,—between the testis and the ovary itself. There is also a smaller mass of milt—another distinct testis—which measures two inches in length, by nearly three quarters of an inch in greatest breadth. It consists of various convoluted lobes, which surround a central ligament-like portion of membrane, and is attached by a pedicle about three quarters of an inch in breadth, a little above the mouth of the ovisac or oviduct; the mass itself lying between the two lobes of the ovary towards its lower extremity. There are five distinct openings, which run nearly in a straight line, and pass through the ligamentous attachment of this testis to the ovisac; these openings are the lower terminations of a series of tubes which divide as they pass upwards into the different lobes of the milt; (bristles have been introduced into them, and thus shew their position).

[1] Read before Royal Physical Society of Edinburgh, 23 March, 1870.

Another and still smaller distinct mass of testis or milt consisting only of two small lobes is attached towards the left side of the opening of the ovisac or oviduct, near its termination; these lobes appear to be hollow, but having been accidentally cut open, their contents may have escaped. The other masses of milt are filled with the usual semifluid contents, which under the microscope shew a mass of small rounded granular-like bodies—probably sperm masses or cells.

The arteries which supply these organs with blood enter the ovary at the upper extremity of each of the lobes, that of the left lobe being the larger. The specimen has been minutely and beautifully injected from this vessel by Mr Stirling of the Anatomical Museum of the University of Edinburgh, the minute anastomosing vessels, both of the ovary and testis, being filled with the injection, and also those of portions of the stroma, or substance of the ovary itself; giving it the appearance of the injection being extravasated there. I am indebted for this specimen to Mr W. Bargh, fishmonger, Earl Grey Street, and it was the first of the kind that had ever come under his notice.

In the month of April, 1865, I exhibited to the Royal Physical Society of Edinburgh an instance of true Hermaphrodism, also occurring in a cod-fish, and a note of it is published in Vol. III. of the "Proceedings" of the Society. Unfortunately one or two inadvertencies have crept into that hurried notice. I may therefore refer to the specimen here a little more in detail. The generative organs were smaller than the example just described; they consisted of a perfect roe or lobe of the ovary on the left side, which measured four and a half inches in length, by about one and a quarter inches in greatest breadth. To the top of this lobe the larger artery of supply was attached. On the right side the organ was compound, consisting of a smaller right lobe of the ovary, measuring three inches in length, by about the same breadth as that of the left side, and lying immediately above it, and attached to its upper extremity by a broad ligament about one inch or so in breadth, were the numerous lobes of a milt or testis, measuring about five inches and three quarters in length by about two and a half inches in greatest breadth, across its ex-

panded lobes. These lobes surrounded a ligament-like portion of membrane (the mesorchium), and tubular canals passed from each lobe into a common canal or 'vas deferens', which opened through its ligamentous attachment into the upper part of the corresponding ovary. The lobes of the testis were filled with rounded granular sperm-like masses, and the ova were distinct in the ovary. This specimen was sent to me by Mr Anderson, fishmonger, George Street. Mr Anderson has been many years in business, and this was the first instance of this peculiarity which he had seen.

Both these instances are therefore examples of true, double, or complex hermaphrodism; combining as they do the apparently perfect male and female organs of generation in one individual.

I have also to notice an example of true, double, or complex hermaphrodism in another fish—the common herring; in which the organs of generation consisted on each side of nearly one half milt and the other half roe, divided transversely. The whole organ measured three and a half inches in length; the upper, larger, and bulkier portion two inches in length, being a distinct testis or milt, and measuring one inch in greatest breadth; the lower and more tapering half, being roe, one and a half inches in length, and half an inch in greatest breadth, the separation or division between them being quite distinct. Unfortunately only one half of the generative organs was preserved, but the other side was of exactly the same character. It is believed that the occurrence of this kind of compound structure is rarer in the herring than in the cod-fish. The specimen was procured several years ago at Wick, that great station for herring fishing, by Mr Joseph Anderson, from whom I received it, and I have the pleasure of depositing these curious specimens in the Anatomical Museum of the University of Edinburgh.

The occasional appearance of these strange peculiarities of compound sexual organs is known I believe to fishermen, no less than to anatomists; and corresponding instances, at least of its occurrence in the cod-fish, have been recorded, but I have not been able to find any notice of these in British Journals.

NOTE ON THE PRESERVATION OF MINUTE ANIMALS IN ACETIC ACID. By T. STRETHILL WRIGHT, M.D. (*Edinburgh*).

SOME years ago, being desirous of preserving specimens of minute and delicate medusæ and protozoa as microscopic objects, I tried acetic acid as a preservative agent. As I have found it to answer this purpose very successfully, I think it well to put the fact on record, as considerable difficulty has been experienced by naturalists in obtaining a fit preservative fluid for these minute organisms.

The medusoid of *Atractylis repens* (Strethill Wright), and a marine *Zoothamnium*, the contractile stalk of which was covered with masses of *Lecythia elegans* (Strethill Wright), *Salpingaeca marina* (Clarke), were prepared nearly ten years ago, and are as perfect now as when first mounted[1]. In the medusoid (1-16th of an inch in length) the microscopic structures, such as the finely-dotted tissue of the muscular sub-umbrella, the thread cells with their included style, and the cell in which each is developed, are rendered beautifully apparent. In the minute *Lecythia*, (the animal of which is not larger than a human red blood-globule,) the delicate-stalked vase in which it once lived, the long contractile funnel which surrounds the mouth, and the flagellum which vibrates within it, together with the contractile vesicles and nucleus, are brought out sharply with a power of 600 diameters. The spiral muscle in the stalk of *Zoothamnium* is also beautifully displayed. In preparing these objects, the animal was placed in a large hemispherical drop of water at the end of a glass slide, and when it was in a favourable state it was suddenly washed off by a deluge of acetic acid into a small vessel full of the same. It was then put up in a shallow cell, either in acetic acid or dilute spirit.

[1] These specimens were shewn at a meeting of the Royal Physical Society of Edinburgh, March 23, 1870.

ON THE SPECIES OF SEAL FOUND IN SCOTLAND IN BEDS OF GLACIAL CLAY. By PROFESSOR TURNER.

NATURALISTS are well acquainted with the fact that in various parts of Scotland the bones of seals have been found at some distance from the present surface of the soil embedded in clay. In many of these localities marine shells such as are now met with only in the Arctic Seas have also been found, and for this and other reasons the beds of clay are regarded by geologists as having been formed at a period when the climate of Scotland possessed an Arctic rigour.

In 1825, Dr Robert Knox[1] directed attention to the bones of a seal found near Camelon, Falkirk, in a bed of clay, 90 feet above the present level of the Forth. Dr David Page presented some years ago to the Edinburgh Museum of Natural History, the almost perfect skeleton of a seal found in 1857 in brick-clay at Stratheden, Fife, 150 feet above the present sea-level, about 16 feet from the surface of the soil, and about 5 miles inland from the influence of the tides. He has also presented to the Museum of Natural History in St Andrew's another skeleton found in 1859 in the same locality[2]. The nearly perfect skeletons of Surf and Eider ducks, *Oidema* and *Somateria*, were found in the same clay as the skeletons of these two seals. Dr Page also tells me that he has obtained seal's bones from the brick-clays at Garbridge and Seafield near St Andrew's, from a brick-field at Dunbar, and from brick clay at Invernetty, Aberdeenshire. In these localities the clay lies in the same horizon as the Stratheden clay, and is glacial in its characters.

Dr Allman records[3] the discovery of seal's bones in a clay-field at Tyrie near Kirkcaldy, 30 feet above the present sea-level, 18 or 19 feet from the surface of the soil, and a quarter of a mile from the shore of the Forth: and in a clay-field at Portobello, near Edinburgh, about 20 feet above the present high-

[1] *Memoirs of Wernerian Society*, v. 572.

[2] These skeletons were exhibited at the meetings of the British Association, 1858, 1859. See *Reports* for those years. The skeleton in the St Andrew's Museum has been carefully described by Mr Robert Walker in the *Annals and Magazine of Natural History*, November 1863.

[3] *Proc. Roy. Soc. Edinburgh*, April 19, 1858, and March 21, 1859.

water level, and about 15 feet below the surface of the soil. The Rev. Thos. Brown[1] obtained portions of the skeleton of a seal from a brick-field at Errol, 45 feet above the present sea-level, and about 1½ miles from the estuary of the Tay. Arctic shells were also found embedded in this clay. Dr Howden[2] procured a large portion of the skeleton of an adult seal from laminated clay, which abounds in shells of an Arctic type at Puggiston, Montrose. I received from Mr Wm. Stirling, B. Sc. in October last a number of seal's bones from Grangemouth near Falkirk, which were met with, whilst sinking a coal-pit shaft, near the bottom of a deposit of red clay, 36 feet in thickness, nearly 80 feet below the present surface of the soil, 68 feet below the present sea-level, and less than a mile from the present estuary of the Forth[3]. The geologists who have examined this clay, pronounce it to belong to the glacial era, though no shells have as yet been found in it.

I examined the bones of the Grangemouth seal with the view of determining, 1st, whether the animal was of the same species as the seals whose bones have been found elsewhere in beds of clay in Scotland by other naturalists; and, 2nd, whether the species is or is not the common seal, *Phoca vitulina*, which now frequents our coasts.

The materials I have had for comparison have been as follows:

A. A few vertebræ, and ribs, with some of the long bones, the right temporal bone, a fragment of the upper jaw with loose teeth, and the lower jaw of the young seal, from Grangemouth.

B. An almost perfect skeleton of the young seal from Stratheden, now in the Natural History Department of the Museum of Science and Art, Edinburgh.

C. Some vertebræ, bones of the limbs, lower jaw, and fragment of upper jaw from the young seal found at Portobello, also in the Museum of Science and Art.

[1] *Trans. Roy. Soc. Edinburgh*, xxiv. p. 269.

[2] *Trans. Edinburgh Geological Soc.* 1868.

[3] I have given a more detailed account of the locality in the *Proc. Roy. Soc. Edinburgh*, Feb. 1870, and the geology of the district has been described by Mr James Croll in the *Trans. Geol. Soc. Edinburgh*, May 1869, and by Mr J. Bennie in *Trans. Geol. Soc. Glasgow*, April 1868.

D. Vertebræ and ribs from the well-grown seal found at Errol.

E. Some vertebræ, ribs, long bones of the limbs, scapulæ, pelvis, lower jaw, and left upper jaw of the adult seal from Puggiston, Montrose[1].

With regard to the first part of the inquiry, it should be stated that in the Grangemouth, Portobello, and Stratheden seals, the epiphyses were not yet anchylosed to the shafts of the long bones, and the size of these, and the other bones which have been preserved, was less than those of the corresponding bones in the Errol and Montrose seals.

In their general form, however, and in the shapes and position of their various processes, the resemblance in most respects was so close, and the differences were so slight, that any that did occur were, I believe, to be regarded as individual merely, and not specific; this view of the specific affinity between these clay-seals is confirmed by the examination of the lower jaws and teeth. For the general shape of the lower jaw is closely similar in all specimens where that bone has been preserved; and the teeth in their number, in the character of the cuspidation, and in the mode in which they are implanted in their sockets, present identical characters.

This identity in the specific characters of the seals found in the clay formations on the east coast of Scotland, is an argument in favour of the view that these clays had been deposited at the same epoch, and under the same conditions.

Before commencing the comparison of the clay-seals with the seals now met with in the northern seas with the view of determining whether they belonged to any of the now existing species, it may be well to see what opinions have been entertained on this matter by previous writers. Dr Knox, remarking on the bones found at Camelon, stated that the seal was identical with the species now inhabiting the Firth of Forth (*Phoca vitulina*), and a similar opinion, as to the species to which the bones of some of the other fossil seals found

[1] My thanks are due to my friends Prof. T. C. Archer, the Director of the Museum of Science and Art, the Rev. Thomas Brown, Dr Howden, and Mr W. Stirling, B. Sc. for permission to examine the various specimens above referred to.

elsewhere belonged, has been expressed by other naturalists. At the time when Dr Knox wrote the specific differences between the various northern seals had not been precisely made out, and the determination is even yet one of much difficulty, unless adult skulls and teeth can be compared with each other. Dr Knox does not say what the bones were which came under his observation, so that we have now no means of knowing how far he had in his possession the materials for making an exact comparison.

Dr Page in describing the Stratheden seal, now in the Museum of Science and Art, expresses himself with more reserve. He looked upon it "as a pretty widely divergent variety of the common seal, if not a distinct species; a point, however, which yet awaits the precise determination of the comparative anatomist."

Mr R. Walker, in his description of the skeleton of the young seal in the St Andrew's Museum, points out very clearly that it is not of the same species as the common seal[1]. He compares it with the drawings of *Phoca hispida* (*Pagomys fœtidus*) given by F. and G. Cuvier, with which he recognises a resemblance, but he is inclined to think that, taking all the characters, the fossil seal has the closest alliance to *Pagophilus* (*Phoca*) *Groenlandicus*, and that it is a young specimen of that species, though there are one or two matters, in connexion with the jaws and teeth, which will require further consideration before deciding.

Dr Kinberg in an essay on the Arctic seals found in the glacial era in Sweden[2], a copy of which he very courteously sent to me a short time ago, states that within a period of but a few months the remains of several individual seals have been found in Sweden. From a comparison of their bones with those of recent specimens, he arrives at the conclusion that the fossils were of the same species as the now existing *P. Groenlandica*. He refers also to some observations made in

[1] Since my paper was in type I have examined, along with Mr Walker, this specimen, and compared it with the bones of the Grangemouth and Montrose specimens. We agree in considering it to be, like the skeleton from Stratheden in the Edinburgh Museum, the same species of seal.

[2] Om Arktiska Phocaceer, funna uti mellersta Sveriges glaciallera. *Öfversigt af Kongl. Vet. Akad. Förhandlingar*, Jan. 13, 1869.

North America by Mr Logan, from which it appears that the bones of an old seal, found along with shells belonging to the glacial period, have been identified with those of *P. Groenlandica.*

In the bones of the limbs many differences may be recognised between the fossil and common seals, some of the most important of which it may be well to note; and I shall make the comparison between the bones of the adult from Montrose and those of an adult *P. vitulina.*

The scapula in the fossil has the præ- smaller in proportion to the post-spinous fossa; the vertebral border is more uniformly convex, and the axillary border has not such a decided hook at the posterior angle as in the common seal. The humerus is more bulky though not longer, and the muscular ridges are more powerful in the fossil than in the recent specimens. The radius and ulna, though with stronger muscular ridges, are not so broad in the fossil as in the recent specimen, though the length is nearly the same in both.

In the os innominatum the iliac crest is more everted, the horizontal ramus of the pubis is much more slender, the pubic spine is broader, the ischial tuber is more pointed, and the os innominatum is one inch and a half shorter in the fossil than in the recent seal. The femur is shorter but with more strongly pronounced muscular ridges, the tibia and fibula, like the corresponding bones in the fore-limb, have stronger marked muscular ridges, but are not so broad in the fossil as in the recent specimen, though in length they are almost alike.

The transverse diameter of the anterior articular surface of the atlas is greater in the fossil than in the common seal, whilst the opposite condition prevails in their posterior articular surfaces, and the ring is markedly smaller in the fossil. The transverse diameter of the base of the sacrum is also considerably smaller in the fossil.

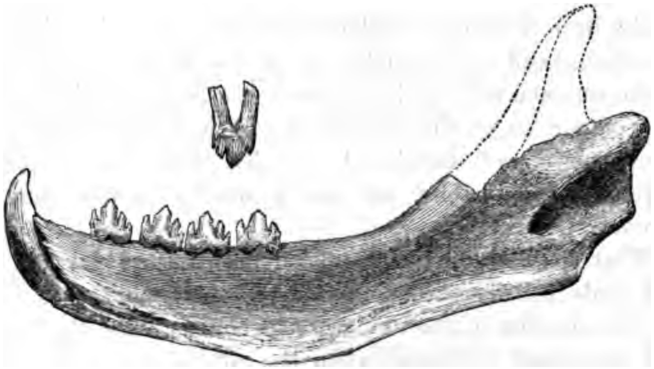
In the fossil seals the skull is either absent or in a fragmentary condition; so that it is not possible to obtain an idea of its form, and to compare it with that of the common seal. In the Grangemouth, Portobello, Stratheden and Montrose specimens, individual bones of the skull, more especially the

temporal bones, upper and lower jaws with the teeth, have been preserved.

The zygoma is more flattened and not so curved at its extremity, and the groove between its root and the squamous part of the temporal bone is narrower in the fossil than in the common seal.

The number of teeth is the same both in the fossil and common seal, but the character and mode of implantation of the molars exhibit important differences. In the clay-seals the number of cusps in the premolar and molar series in the lower jaw does not exceed four, and this number is distinctly marked in all but the first and the last. The second cusp in each tooth is the largest, but it does not preponderate very greatly over the first and third cusps, and the bases of the crowns are not much swollen. The teeth are set in the jaw in longitudinal series, one directly behind the other.

Fig. 1.



Inner surface of the right half of the lower jaw of the Grangemouth fossil seal, the size of nature. The anterior tooth in the molar series has been lost. The outline of the coronoid process is filled in from the Portobello seal. The single tooth is one of the upper molar series.

In both young and well-grown specimens of the common seal the molar teeth are set obliquely in the jaw, so that a tooth not only lies in front, but somewhat to the outer side of the one behind it. The cuspidation of the lower molars is not so uniform as in the clay-seals: the last molar has four cusps, the penultimate five, and the third and second only three. One

cusp preponderates largely over the others, and the base of the crown is swollen.

The upper molars in the clay-seals are smaller and more delicately formed than in the common seal. They are, as a rule, tricuspidate, and with, as a rule, the central cusp the largest. They are not set obliquely, and the more anterior do not overlap those which lie behind. In the common seal, again, the anterior cusp is usually the biggest; and the upper as well as the lower molars are set obliquely.

Both in size and form the lower jaw of the fossil seal differs from the common seal; and as this bone exhibits specific differences in the various kinds of seals, it may be well to compare it not only with the common seal, but with the corresponding bone in the other northern seals.

In the following table the dimensions of this bone taken in straight lines, measured from various specimens in the Anatomical Museum of the University of Edinburgh, are expressed in inches and tenths.

An inspection of this table will at once show that the lower jaw of the fossil seal is smaller in all its dimensions than that of the common seal; and from what has been already stated in the comparison of the other bones, it is clear that the fossil though with well developed muscles, and active doubtless therefore in its habits, yet was a smaller animal than the common species.

That specific differences existed between the clay and common seals I had satisfied myself of, some months ago, from the examination of the immature specimens[1], and the truth of this was amply confirmed when the adult Montrose specimen reached me.

When the lower jaws of the young specimens only were under examination several striking resemblances were noticed between them and that bone in the Greenland seal. In the number of the teeth, the relative size of the cusps, and in the mode in which the fangs were implanted in the jaws, the fossil agreed closely with the Greenland seal, though the teeth were set more closely together in the former than in the latter animal: a difference which (together with certain differences

[1] See *Proc. Roy. Soc. Edinburgh*, Feb. 1870.

	Adult fossil, Montrose.	Young fossil, Grange-mouth.	Phoca Vitulina.	Phoca hispida.	Phoca barbata.	Phoca Groenland.	Halichoerus grypus.
Length from posterior border of condyle to socket of canine tooth.[1]	4.2	3.3	4.9	4.0	5.5	5.1	6.1
Vertical diameter of horizontal ramus opposite last molar.	0.8	0.6	0.9	0.8	1.0	1.0	1.0
From posterior border of ascending ramus just above the tubercle at angle to last molar tooth.	1.9	1.6	2.3	2.1	2.7	2.4	3.0
Vertical diameter of ascending ramus from condyle to angle.	1.6	1.0	1.8	1.4	2.0	2.4	2.1
Transverse diameter of the articular condyle.	0.7	—	0.9	0.8	1.2	0.9	1.3
From posterior border of last molar to canine socket.	1.3	1.2	1.7	1.5	2.1	1.8	2.1

[1] The measurement is made to this socket as the incisive part of the jaw is broken away in the fossils.

in the form of the jaw), it was thought might perhaps have been due to the immaturity of the fossils, so that I was at one time inclined to think that the clay-seal might be the *P. Groenlandica,* but after an examination of the adult fossil, I satisfied myself that this could not be the case. For not only was the fossil much smaller than the Greenland seal, but the mode in which the cusps of the teeth were worn down and the form of the lower jaw were also different, so that one could no longer regard them as identical.

If we once more revert to the table, we shall see that the only northern seal which closely corresponds in the dimensions of its lower jaw with the fossil is the *Pagomys fœtidus,* Gray, (*Phoca hispida,* Cuvier). It will be necessary therefore that we should institute a close comparison between these bones in the two animals. Their correspondence in general form is very striking; they both possess on the outer surface of the ascend-

Fig. 2.

The upper figure shows the ascending and a portion of the horizontal ramus of the lower jaw of the adult Montrose clay-seal. The lower figure shows the corresponding part of the jaw of an adult *Phoca hispida.* Both figures are the size of nature. In the Montrose seal the coronoid process is broken off.

ing ramus a deep masseteric fossa, which is bounded posteriorly by a ridge which lies close to the posterior border of the ascending ramus of the bone, and extends upwards to the outer end of the condyle. In *P. hispida* this ridge is rather more vertical than in the fossil. They both possess a well-defined tubercle at the angle of the jaw, which is somewhat larger in *P. hispida* than in the fossil. Above this tubercle there is in both a slight constriction, above which an elongated almost vertical ridge somewhat more incurved in the fossil than in *P. hispida* forms the posterior border of the bone. This ridge contrasts strongly in its character with the corresponding part of the jaw in *P. Groenlandica*, in which seal it possesses the form of a large triangular tubercle, which projects obliquely backwards and inwards. Both in *P. hispida* and in the fossil the coronoid process slopes more gently upwards and backwards than in *P. Groenlandica*. In both also the lower border of the horizontal ramus is incurved opposite the last molar tooth, behind which incurved portion this border of the bone sweeps backwards and outwards in a graceful curve; in both the arrangement and cuspidation of the teeth are very similar, although the intervals between the anterior molars are somewhat greater in *P. hispida* than in the fossil.

In both seals the margin of the anterior nares ascends somewhat abruptly from the horizontal part of the premaxilla, and in this respect contrasts strongly with the form of the anterior nostril in *P. Groenlandica*, in which the margin of the nares is much more oblique.

The upper dental series closely corresponds in *P. hispida* and in the fossil, in size, arrangement, and cuspidation.

Unfortunately the palate bones have not been preserved in the fossil, but the posterior palatine foramen obviously opened, as in *P. hispida*, in the palato-maxillary suture. The length from the posterior border of the last molar tooth to the front of the premaxilla is in the fossil 2 inches, in *P. hispida* 2·2 inches. There is a close correspondence in the form of the temporal bones in the two seals.

The affinity therefore of the fossil seal to *P. hispida* is of a very striking character, and the differences between them are so trifling that they are to be regarded I believe as individual

merely and not specific. So far then as I have had access to materials for comparison, I am of opinion that the seal, remains of which have been found in the brick-clays in so many parts of Scotland, was identical with the smallest of the now existing Arctic seals, namely, the Floe-rat or *P. hispida*.

I am not aware that there is any satisfactory evidence to show that this seal ever visits our shores at the present day, so that we may consider that the determination of its bones in the brick-clays is an additional argument, to those advanced from other data, that, at the time when these clays were deposited, the climate of Scotland possessed an Arctic rigour.

NOTE ON THE CAPTURE OF THE GREY SEAL, HALICHOERUS GRYPUS, ON THE COASTS OF FIFE AND FORFAR. By PROFESSOR TURNER.

EARLY in the month of March a large seal was captured alive in the stake nets belonging to Mr Speedie of Perth at the Tents Muir Station, Mouth of Eden, near St Andrew's. It was taken alive to Perth and then killed. Through the kindness of Dr Stirling of Perth I was enabled to secure the viscera and bones for the Anatomical Museum of the University. The seal was an adult female, and its cranial and dental characters were those of the Grey Seal, *Halichoerus grypus*. The length was 7½ feet; the weight 33 stones. The hair was nearly black on the back, gradually lighter on the sides, but spotted with black, whilst the belly was lead-coloured, with black spots. A large corpus luteum was in the left ovary, but the uterus was empty. The dimensions of the lower jaw are given on p. 267.

In the spring of last year two young seals, captured in the salmon nets near Montrose, were sent by Dr J. Wilson Johnston to the Museum of the University. Although the skulls were much broken, yet the jaws and teeth showed them to be the young of the *Halichoerus grypus*.

Mr Ball was the first naturalist who, from specimens caught on the Irish coasts, satisfactorily established this seal to be

a native of the British Islands, and Mr Bell, on his authority, admits it amongst the British Mammals. It has been repeatedly shot in Shetland, Orkney and the Outer Hebrides, but I have not met with any notice of its capture on the East Coast of Scotland, though Dr Gray gives the Northumberland Coast as its habitat.

Though not so numerous as the common seal, *Phoca vitulina,* yet I believe it will be found a regular dweller on the east coast, though from its cunning and wariness it is difficult to capture. It is much disliked by the fishermen from the injury it does to the stake nets, and from its destruction of the salmon. Dr Stirling tells me that the fishermen of the Tay call it the black seal. Last year he says very few were seen, but this season, more than any year for six years past.

ON THE STERNUM AND OSSA INNOMINATA OF THE LONGNIDDRY WHALE (*Balaenoptera Sibbaldii*). By PROFESSOR TURNER.

IN the early part of November 1869, a large, female, Fin whale was stranded at Longniddry on the Firth of Forth[1]. From the colour, from the general proportions and anatomical characters, I believe it to have been an example of the whale called Steypireyðr by the Icelanders, a description of which by Professor Reinhardt has recently appeared in the "Annals of Natural History" (Nov. 1868). The Steypireyðr has been identified with the *Balaenoptera Sibbaldii* or *Physalus Sib-*

[1] I gave a description of this large Cetacean to the Royal Society of Edinburgh on Dec. 20, an abstract of which was printed in their *Proceedings* of that date. Shortly afterwards I learned that in the month of October a great Finner came ashore at Hamna Voe, Northmaven, Shetland, of which Mr J. Walker, of Maryfield House, Bressay, has kindly sent me the following particulars. The animal was a female and with calf. The length obtained by pacing, which can only be regarded therefore as an approximation, was said to be for the mother 92 feet, for the calf 30 feet. The belly had the longitudinal ridges and furrows, and a small dorsal fin was present towards the tail. The back was black, and the belly mottled with silver-grey tints. The baleen was black. The beak was broad in the greater part of its extent, and tapered off gradually towards the tip. I believe it to have been of the same species as the Longniddry whale.

baldii of Gray. The length, measured along the curvature of the back, from the tip of the lower jaw to the end of the tail, was 78 feet 9 in. From the non-union of the disk-like epiphyses of the bodies of the thoracic and lumbar vertebræ, the animal had not reached the adult state, but was in the condition which Mr Flower has termed adolescent[1], a condition in which, as he points out, the reproductive functions have come into action; for the whale was gravid with a male calf, 19 ft. 6 in. long.

I secured the calf for anatomical examination; and as the skeleton of the adult was purchased by Prof. Archer for the Natural History Department of the Edinburgh Museum of Science and Art, I have been enabled to examine the osteology of this whale and the development of the bones.

In this communication I propose to give an account of the sternum and ossa innominata, bones to which in the Cetacea much interest is attached by anatomists, and which have not apparently been previously described in so large a specimen of this species of *Balaenoptera*.

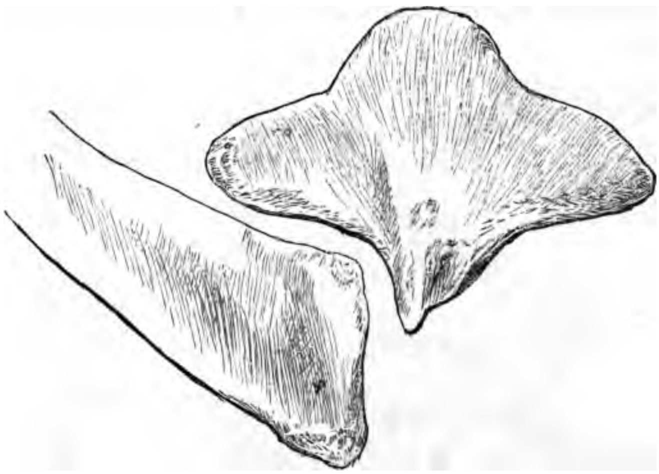
Sternum in the adolescent female.

The sternum was a flattened and expanded bone, in general form like a trefoil leaf, with a posterior pointed process or pedicle. Its greatest transverse diameter was 26½ in., its antero-posterior diameter 17½ in. Its lobes were an anterior and two lateral. The anterior lobe had a rounded border and measured 12¼ in. transversely at its root. The lateral lobes were more elongated and not quite symmetrical, and the greatest antero-posterior diameter was not more than 7½ in. The posterior pointed process, 5½ in. long, was continuous by a broad base with the posterior border of the body of the bone; its transverse diameter at the base was 7¼ in.; its left border was thicker and much more projecting than the right border. The thoracic surface of the sternum showed a shallow transverse concavity. The pectoral surface was convex over the root of the pedicle, but the body was concave in the antero-posterior

[1] *Proc. Zoological Society*, Nov. 8, 1864.

direction. The posterior border of the bone was much thicker than the anterior.

Fig. 1.



Pectoral surface of the sternum, and of the sternal end of the right rib, reduced $\frac{1}{11}$th. For this and the other drawings in illustration of this paper I am indebted to my pupil, Mr Millen Coughtrey.

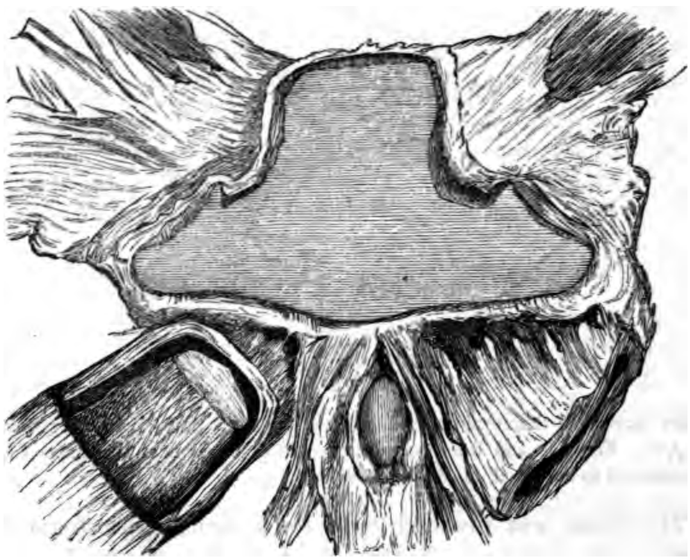
The bone was invested by a thick, dense periosteum, to which it was not very adherent, so that when the periosteum was cut through the bone was easily lifted out of its fibrous sheath. The periosteum lying next the bone consisted of a well-marked layer of a dull yellow, soft material which formed, I believe, the osteo-blastema concerned in the formation of the superficial portion of the sternum. A similar layer was also seen in connection with the deep surface of the periosteal sheaths of the other bones. The sternal end of the first rib, enclosed in its periosteum, fitted into the interval between the side of the pedicle and the lateral lobe of the sternum.

Sternum in the male fœtus.

The sternum was cartilaginous throughout, and consisted of two distinct segments. The anterior, much the larger, a three-lobed flattened plate of cartilage, represented the three lobes of the adult sternum. It measured 5·8 in. in its greatest transverse and 3·4 in. in its antero-posterior diameter. The anterior lobe was not so rounded as in the adult bone, the lateral lobes were more

pointed, and close to the angle of junction of these lobes a short pointed process of cartilage projected forwards for about $\frac{3}{10}$ths of an inch. The posterior border of the three-lobed portion of the sternum was sinuous. A second almond-shaped

Fig. 2.



Sternal arrangements of fœtal *Balaenoptera Sibbaldii* reduced a little more than one half.

cartilage, 1·1 in. long and 0·6 in. in its greatest transverse diameter, was situated 0·7 in. behind the posterior border of the first piece of the sternum. It reprèsented the pedicle of the adult sternum. Each segment of cartilage possessed a distinct and perfect perichondrial sheath. But whilst the cartilages themselves were altogether discontinuous, the anterior part of the sheath of the smaller cartilage was continuous with the middle of the posterior part of the sheath of the larger cartilage. The degree of adhesion between the cartilage and the smooth inner surface of the perichondrial sheath varied, for whilst in some places they were easily separated, in others the knife had to be used to detach them from each other.

The tendons of a pair of strong muscles were connected to the perichondrium, where it covered the sides of the anterior,

and the anterior borders of the lateral lobes. These muscles extended forwards and outwards, and were apparently the sterno-mastoid muscles. In the angle between the posterior border of the lateral lobe and the smaller amygdaloid cartilage the first rib was situated, and its thick and dense periosteal sheath was connected by strong ligaments to the perichondrial investment of the left lateral lobe.

In the interval between the sheath investing each first rib, and the sheath of the amygdaloid cartilage, a pair of very slender muscles with delicate fasciculi was situated. These muscles extended from behind forwards and inwards, and were attached in front to the posterior border of the perichondrium of the three-lobed cartilage a little on one side of the middle line. Each muscle lay in a distinct fibrous sheath, and one was placed in relation to the ventral surface of the other. These muscles from the direction of their fibres would act as retractors of the sternum.

In Fig. 2 the sheath of the right first rib has been opened into so as to display its sternal extremity. The rib itself is ossified, and the bone possesses a characteristic fibrous texture. A distinct but short plate of cartilage situated at the anterior end of the bone obviously represents the costal cartilage or sternal element of the rib. No subdivision of the interior of the dense periosteal sheath, by a membrane into two separate parts, such as has been described by Eschricht and Reinhardt[1] in the fœtal *Balaena mysticetus*, was seen in this *Balaenoptera*, either in the first, or any of the succeeding ribs.

In none of the skeletons described by anatomists, which have been referred to the *Balaenoptera* or *Physalus Sibbaldii*, has so well-developed a sternum been seen as in the specimen just described. In the Hull skeleton, on which Dr Gray founded the species, Mr Flower states that the sternum is wanting. In the skeleton from Utrecht, now in the British Museum, the sternum, as Mr Flower has pointed out, is an irregularly oval bone, only $5\frac{3}{4}$ inches in its transverse, and 4 inches in the antero-posterior diameter, so that the bone is almost rudimentary. In the whale, described by Professor Malm of Gothenburg, as

[1] Ray Society's translation of their memoir on the Greenland Right Whale, p. 118.

B. Carolinae, but which Professors Reinhardt and Flower consider to be a specimen of the *B. Sibbaldii*[1], the sternum, as far as can be gathered from Malm's figure, is only partially ossified, and it is difficult to say how far the outline, which he gives, accurately depicts the correct form of the bone. Amongst the bones obtained by Professor Reinhardt from the Steypireyðr the sternum was not present.

The Hull, Utrecht, and Gothenburg skeletons are from much smaller and more immature animals than the Longniddry whale, so that the form of the bone as exhibited in the Utrecht and Gothenburg specimens, where the sternum has been preserved, is not so characteristic of the species as the sternum from the Longniddry skeleton, which had almost reached the adult stage of growth.

Comparative anatomists have pointed out as a well ascertained fact in the osteology of the Cetacea that essential differences exist in the composition and mode of formation of the sternum in the whalebone and the toothed whales. Thus MM. van Beneden and Paul Gervais, in their admirable treatise on the *Ostéographie des Cétacés*, now in course of publication, state that "the sternum is always simple and formed of a single bone in the baleen whales, whilst in the cetodonts it is always formed of several bones which lie in series. In the baleen whales there is only one point of ossification, and in the cetodonts there are several, and they occupy the two longitudinal halves of this bone. The baleen whales have thus a sternum formed of a single piece, which has a shield-like form, and a single point of ossification gradually spreads throughout the cartilage."

Whatever may be the case in the other Balaenoidea, there can be no doubt that in the *B. Sibbaldii* the sternum is not developed in the simple manner described in the above paragraph. There can, I think, be no question that the three-lobed and amygdaloid segments of cartilage, which I have described and figured from the fœtus, are the cartilaginous framework of the adult sternum, the one representing the larger three-lobed por-

[1] *Vidensk. Meddel. fra den naturhist. Forening*, 1867. Copenhagen. Translated in *Annals of Natural History*, Nov. 1868. *Proc. Zoological Soc.* March 12, 1868.

tion, the other the pedicle. Though no trace of ossification is to be seen in either, yet it is probable that a separate ossific nucleus would have formed independently in each cartilaginous segment.

As the segments are however separated from each other by a distinct interval, the junction of the ossifying pedicle with the larger anterior portion of the bone could only have been effected after the ossification of the intermediate fibrous perichondrial (osteal) sheaths, so that the sternum, after this junction had occurred, would, though mainly a cartilage bone in its construction, yet to some extent, have had its foundation laid in fibrous tissue. In the sternum of the adolescent animal no depression, or other mark, on the exterior of the bone indicated where the junction between the two originally distinct cartilaginous segments had occurred, so that it is probable that the blending takes place soon after the commencement of the ossific process.

All anatomists will, I think, admit that the larger anterior segment is the manubrium or præsternum, for the first pair of ribs is connected with it. There may be a difference of opinion whether the amygdaloid cartilage is a rudimentary meso- or xiphi-sternum. I believe it should be regarded as the xiphoid element, and that the very well marked interval between it and the præsternum points to the locality in which the missing meso-sternum ought to have been developed.

Mr Kitchen Parker in his elaborate *Memoir on the shoulder girdle and sternum* regards the blunt pointed process, growing backwards from the trilobate præsternum of *B. mysticetus,* as a xiphoid rudiment, and he puts a similar interpretation on the posterior process of the sternum in *Balaenoptera rostrata, musculus,* &c.

But the development of this process, at least in the *mysticetus* and *rostrata,* is not the same as in *B. Sibbaldii.* For Eschricht and Reinhardt figure it in *mysticetus* as a continuous piece of cartilage with the præsternum, and van Beneden and Gervais give a figure (p. 23), from Gratiolet, of the sternum in *B. rostrata* in which not only is the cartilage of the præsternum continuous with that of the posterior process, but the ossification of both proceeds from the same ossific nucleus.

From the difference in the mode of development of the posterior process there is reason to think that they are not morphologically identical, and if the amygdaloid cartilage in *B. Sibbaldii* be the xiphi-sternum, then the posterior process in *mysticetus* and *rostrata* may either be regarded as a rudimentary form of a meso-sternum or simply as a pointed portion of the præsternal cartilage.

If the sternum of *B. Sibbaldii* be now compared with the sterna of the three fin-whales figured by Mr Flower in *Proc. Zool. Soc.*, Nov. 8, 1864, it will be seen that it differs very materially in shape from that bone in *B. rostrata* and *Physalus antiquorum;* but that it is not unlike the sternum of the *Sibbaldius Schlegelii*, a Java whale, the skeleton of which is in the Leyden Museum: though from van Beneden's drawing of this bone, Fig. 29, Pl. XIV., XV., it would seem that the sternum in *Schlegelii* possesses a peculiar incurvation of the edge of its posterior process, which does not exist in *B. Sibbaldii.* But there is still another important difference in the relative size of the bone in the Longniddry and Java whales, for although the latter animal had nearly attained its adult dimensions, yet its sternum is less than half as large as that bone in the Longniddry specimen.

I have also compared the sternum with Dubar's drawing of the Ostend whale in his *Ostéographie de la Baleine.* Dubar's measurements of 40 cm. long by 50 cm. broad, give a smaller bone than in the Longniddry Whale. There is a certain general correspondence however in the form of the bone in the two animals. The ossific process however, as far as one can judge from the drawing, seems to have been more exuberant in the Ostend whale, for not only is the posterior process broader, but the angles between the lateral and anterior lobes are filled up with a greater proportion of bony growth.

Os innominatum in adolescent female.

The ossa innominata were placed on the sides of the ventral surface of the animal, about 2 feet from the side walls of the vagina, and about 22 feet in front of the end of the tail. No connection across the middle line anteriorly was seen between the antero-inferior ends of these

bones. Each bone was elongated and curved; convex on the outer surface, concave on the inner. It consisted of three processes springing from a common centre. One process was short and tuberous; a second projected backwards and upwards for 9 in. and ended in a blunt extremity; the third curved

Fig. 3.

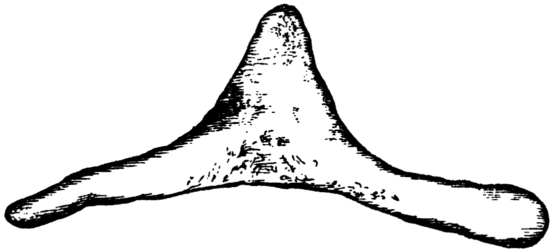
Outer aspect of right os innominatum of adolescent female, reduced ⅛th.

downwards and forwards, tapered at its free end and had a hook-shaped extremity. The bone measured in a straight line between the tips of the anterior and posterior processes, or limbs, 17 inches; whilst the greatest depth of the bone was 4½ inches. The posterior margin of the bone was thin, the anterior rounded. The two bones were not quite symmetrical and varied somewhat in the degree of their curvatures; the right also being much more concave on its inner surface than the left. Each bone was invested by a thick periosteal sheath.

Os innominatum in male fœtus.

In the fœtus each innominate element consisted of an elongated curved plate of cartilage, which had the same general

Fig. 4.



Outer aspect of the cartilaginous left os innominatum of the fœtal *B. Sibbaldii*, a little more than ⅔rds the size of nature.

form as the bone in the adult, but with its curvature not so strongly marked. The difference between the two will be more readily recognized by comparing Figs. 3 and 4 than by an elaborate description. The distance between the extreme ends of the cartilage was 3·9 inches, whilst the greatest depth was 1·1 inch. The perichondrial sheath was strong, and afforded attachment to muscles and tendons. Connected to the perichondrial investment of the broader, rounded, posterior end of the cartilage was the strong fibrous envelope of the crus penis, which passed forwards to join its fellow, so as to form the corpora cavernosa penis, on the ventral surface of which the urethra, enclosed in the corpus spongiosum, was situated. A muscle attached to the corpus cavernosum and crus occupied the position of the erector penis. From the attachment of the crus penis to the posterior superior limb of the os innominatum, the latter must be regarded as representing the ischial element of the bone. I think it not unlikely that the antero-inferior slender process may, from its position and direction, represent the pubic element of the os innominatum. Whether the bone, as seen in the adult animal, is developed from one or more points of ossification, I am unable to say. The general correspondence in form between the bone in the adolescent female, and its cartilaginous representative in the fœtal male, proves that in the process of ossification no important change takes place in its external configuration, and that the pelvis of the male possesses the same general form as that of the female.

The observations of Eschricht and Reinhardt on the rudimentary femur and tibia in *Balaena mysticetus*, those of van Beneden on the rudimentary femur in *Megaptera*, and the discovery by Mr Flower of a cartilaginous nodule—the representative of the femur—attached to the pelvic bone of *Physalus antiquorum*, led me to inquire if any corresponding arrangement existed in this *Balaenoptera*.

In the adolescent animal, no rudimentary bone was seen in this locality. The difficulties attendant on the dissection of the huge creature rendered, however, the examination into this point not so complete and satisfactory as I could have desired. But with a much more perfect command over the dissection of the fœtus, I was unable, after a very careful search, to recognize any os-

seous or cartilaginous element, which could be regarded as the representative of the appendicular skeleton of the hinder limb.

The innominate bone in the adolescent animal differs in form from the same bone as figured by Mr Flower in *Physalus antiquorum*[1]. The curvature of the bone in the latter animal is not so decided, the relative length of the two major processes is not the same, and there is an absence of the hook-like termination to the more slender antero-inferior process or limb of the bone. The shape of the pelvic bone in *Physalus antiquorum* approximates more closely indeed to that of the fœtal than of the adult *B. Sibbaldii*.

With the pelvic bone of the Ostend whale, as figured by Dubar, that of the Longniddry whale corresponds in many particulars: in general form, in the amount of curvature, and in the presence of a hook-like process, the correspondence is very close, and the relative measurements, although not exactly similar, yet present no great divergence. With this bone, however, as with the sternum, the ossification seems to have been more exuberant in its character in the Ostend than in the Longniddry specimens, so that the bone is more clumsy in its form in the former than in the latter. Into the question of the specific, or non-specific, identity of these two animals, I shall not enter in this communication; I may merely state that there are various other resemblances in anatomical structure, than those I have specially referred to, which lead me to think that the Ostend whale, instead of being a distinct genus, may, after all, have been only a more aged specimen of the *B. Sibbaldii* than the Longniddry whale.

[1] *Proc. Zool. Soc.*, Nov. 28, 1865.

REVIEWS AND NOTICES OF BOOKS.

Eierstock und Ei, ein Beitrag zur Anatomie und Entwickelungsgeschichte der Sexualorgane von WILHELM WALDEYER, Dr Med., Professor der Medicin an der Universität Breslau, mit 6 Tafeln Abbildungen: pp. 174, 8vo. verlag von W. Engelmann, Leipzig. This is an important and interesting addition to our knowledge of the difficult and much debated subjects of the structure and development of the genital organs, and more especially of the ovary and ova. The author has investigated the structures in a very thorough manner, and gives the results of his own observations with an analysis of the labours of his predecessors clearly and fully. He does justice to other labourers, British as well as German, in the same field, making ample reference to their works; giving, indeed, a condensed abridgement of the literature of the subject discussed in each chapter as a prelude to the account of his own observations. Of these the most important is the fact first pointed out by him that the ovary has not, at any period, a peritoneal covering corresponding with that of the other abdominal organs. The tunic with its tesselated epithelium ceases at a tolerably defined line encircling the pedicle by which the ovary is connected with the broad ligament. This line, which is readily recognised by the naked eye, had attracted the attention of Farre (who, *Cycl. Anat.* v. 548, especially remarks that beyond this line no effort of the scalpel suffices to detach the peritoneal lamina from the tunic beneath) and some other observers; but, for want probably of sufficiently accurate investigation, they failed to recognise its significance. Beyond this line the organ loses the smooth shining serous surface, and acquires a duller greyish-red mucous appearance; the epithelium is softer, more readily scraped off, and is subcylindrical; the boundary between the mucous epithelium on the ovary and the fine serous epithelium of the peritoneum being commonly sharply defined and very clear. During the fœtal state processes of the mucous epithelium grow into the delicate substratum of areolar tissue, which then makes up the chief structure of the ovary, reminding us of the ingrowing processes of cutaneous epithelium from which Kölliker has shewn that the hair and the sebaceous and perspiratory glands are developed. These processes, at first short, conical or flask-like, become elongated, branched and subdivided by the growth of areolar tissue compressing and segmenting them. In the portions thus isolated certain of the (epithelial) cells enlarging and becoming spherical, as well as nucleated and nucleolated, constitute the "ova," while the remaining cells becoming more cylindrical and arranged in a circle form the lining of the Graafian vesicles. The ingrowth and subdivision of epithelial processes and the consequent development of ova has in most animals ceased before birth, by which time an abundant production of ova

has taken place (many of which subsequently degenerate and are absorbed), and the superficial stratum of the areolar tissue beneath the covering epithelium becomes thickened into the tunica albuginea. The conclusion therefore is, that all the ova as well as the epithelial lining of the Graafian follicles are a direct product of the germinal epithelium upon the surface of the ovary. The yolk is regarded as being furnished by the cells which line the Graafian vesicle; and the granular substance which forms the middle and chief part of the "corpus luteum" is produced from the same source, and its colour is caused, not as has been supposed by the effusion of blood, but by the presence of matter of the same kind as that which gives colour to the yolk.

A detailed account of the ovary, ova and follicles of the several vertebrate orders, and of some invertebrates, as well as of the corpus luteum, completes the first part of the work. The second part relates to development.

The author agrees with preceding writers in regarding the Wolffian bodies and their ducts as the parts from which, or in connection with which, the kidneys and male genital organs are formed, and Müller's ducts as the rudiments of the Fallopian tubes. He has worked out the development of these primary structures more closely and with greater care than has hitherto been done, and the results are highly interesting. He traces the first rudiments of the Wolffian ducts and of the Müller's tubes, which are the first found parts, to different though nearly contiguous cells at the sides of the axial string or primary mass from which the protovertebræ, the neural canal, and other mesial structures are developed. A small eminence or ridge in the middle layer of the embryo, on either side of the axial string, has hitherto been regarded as the source of the Wolffian duct. According to Waldeyer, however, that is not strictly the case; the duct being formed not by a hollowing or tubulating of this ridge, but on its mesial side by the formation of a groove, which deepens and is converted into a canal by the meeting and coalescence of its edges. Whence the cells which line this groove and which form therefore the epithelial lining of the Wolffian duct are derived he is not quite certain; but seeing the mode in which the elements of the several embryonic layers (particularly the middle, or osseo-muscular, and the outer or neuro-cutaneous) are still blended at this early period and near the mesial line—the differentiation here taking place later than in the more lateral regions—he is inclined to think that these cells are derived from the outer or neuro-cutaneous stratum. Transverse processes from the fore part of the duct growing outwards, coming into contact with and enclosing small vascular knots developed in the contiguous tissue, form the Wolffian body. At a subsequent period the ureter is developed from the Wolffian duct by a gutter-like projection from its wall which becomes shut off from it; and the kidney is formed by outgrowths from the fore part of the ureter much as the Wolffian body was formed by outgrowths from the Wolffian duct. The anterior and larger part of the Wolffian body now wastes, while the lower part is developed into the epididymis, and he thinks also

affords a nidus in part for the seminiferous tubes of the testicle. Thus the Wolffian body consists of a urinary and a genital part, and the one duct is at first common to the two parts; a condition which is persistent in amphibians and some other cold-bloods, because in these animals the whole of the Wolffian body remains as the kidney. In all warm-bloods the urinary part of the Wolffian body shrinks; a secondary kidney and ureter being formed in the manner described.

The female genital organs are developed in a somewhat similar manner, but from a different source. No sooner has the well-known fissure commenced which subdivides the middle or osseo-muscular layer of the lateral plates of the embryo, and which constitutes the visceral or pleuro-peritoneal cavity, than it is seen to be lined, especially near the axial part where the Wolffian bodies are forming, by well-marked germinal cells, which soon form a layer of cylindrical epithelium. He believes that originally these cells line the whole of the peritoneal cavity but subsequently disappear, and the ordinary serous epithelium is produced in its place, except near the middle line in the genital region, where it increases in thickness and becomes projected by an accumulation of areolar tissue which forms the stroma of the ovary. This germinal or mucous epithelium is the source of the ova and Graafian vesicles as already mentioned, and is here persistent more or less distinctly through life. Müller's tubes (the Fallopian tubes) are formed by a linear or gutter-like ingrowth of this epithelium along either side of the axis of the embryo with a subsequent coalescence of the edges of the groove, just as the Wolffian ducts are formed by an ingrowth of cells from the outer surface of the axial string; and they continue quite distinct. The duct remains open in front; and the epithelium which lines it, and which is remarkable and distinguishable from that of the Wolffian duct by its thickness, is thus at first continuous with, and of the same nature as, that upon the surface of the ovary. Subsequently, owing to the growth and projection of the Wolffian body, the opening of Müller's tube is separated from the ovary. Still it is not unfrequent in animals, and occasionally occurs in the human subject, that the continuity of the mucous covering of the ovary and that of the Fallopian tube is maintained through life by a channel or a narrow band with cylindrical epithelium passing from the one to the other.

It should be observed that the germinal epithelium of the middle serous or peritoneal cavity is not confined to the female. It exists also in the male; but in the latter it disappears from the whole surface, whereas in the female it remains and acquires increased development over the ovary; and one of the first evidences of a difference in sex is afforded by the increase or diminution of the epithelium in this region. The tissue in which the seminal tubes are developed is apparently the same as that which is converted into the stroma of the ovary; and the author was at first disposed to think these tubes are formed, like the Graafian vesicles and ova, by ingrowing processes from the covering layer of germinal epithelium. This view, however, was not confirmed; and the difference between the two sexes consists not simply in the persistence of the germinal epithelium, but in the

fact that in the female this epithelium forms the essential part of the ovary, whereas in the testicle the seminary structure is developed from the processes of the Wolffian duct. It follows that though the stroma of the male and female genital glands may be homologous, neither the actual seminary structure nor the ducts can be said to be so.

The Cell Doctrine: its history and present state, by JAMES TYSON, M.D., Lecturer on Microscopy in the University of Pennsylvania. 1870. This small volume gives a continuous history of the evolution of the "cell doctrine" up to its present stage, with a copious bibliography of the subject, together with the views of the author, which coincide very nearly with those of Dr Beale. It is intended chiefly for the use of students, is clearly written, and shews the author to be a well-read and thoughtful man.

Die Knochen und Muskeln der Extremitäten bei den Schlangenähnlichen Sauriern, vergleichend-anatomische Abhandlung von MAX FÜRBRINGER, Dr Phil., mit sieben Tafeln. Leipzig, Verlag von W. Engelmann, 1870. 4to. pp. 135. This work may take place beside Rüdinger's treatise *Die Muskeln der vorderen Extremitäten der Reptilien und Vögel*, noticed in Vol. III. p. 193 of this *Journal*. Though more limited in its area than Rüdinger's treatise, it covers that area more completely—including an account of the bones as well as the muscles, and of the pelvis and hind-limbs, as well as of the shoulder-girdle and fore-limbs; and a great part — the latter half almost— of the work is occupied with comparisons of the fore and hind-limbs, of the limbs of different Saurians and of these with the limbs of other vertebrates, all which is done very carefully; and though no important generalizations may be attained, the material collected is very valuable, and will form a storehouse for reference for future observers. The author adheres to the views of Owen with regard to the general homologies of the scapular and pelvic girdles, regarding them as modified pleurapophyses and hæmapophyses, and regarding the shoulder-girdle as an appendage to the occipital vertebra. He is apparently not cognisant with other views which have been taken of this question, and is not acquainted with the admirable treatise *On the Shoulder-girdle and Sternum*, by our countryman Mr Parker, of which a notice was given in Vol. II. of this *Journal*, p. 374. In the nomenclature and special homologies of the shoulder-girdle, he follows Gegenbaur, Vol. II. of this *Journal*, p. 155; and in those of the pelvis of Saurians, he adopts in the main the views of Gorsky. Thus (p. 33) that which is usually regarded as the os pubis in Saurians, though in many instances, as the Crocodile, it forms no part of the acetabulum, he considers to be merely the representative of the ilio-pectineal eminence of that bone in mammals (not the marsupial bone); and he accepts, therefore, the name *os ileopectineum* given to it by Gorsky. This anatomist conceives that the remainder of the pelvis, in these animals, is formed by the *ileum* and the *os pubis*,

and that the *ischium* is not present as a bone, being represented only by the *ligamentum ischiadicum*, the obturator hole being situated between this ligament and his pubic bone; and he gives the name *foramen cordiforme* to that which is usually called the *foramen obturatorium*. Here Fürbringer differs to some extent from Gorsky, inasmuch as he considers the pubic bone of the latter to represent both the pubic and ischiatic bones, constituting an *os puboischium*, and that the obturator foramen is not behind this bone between it and ischiatic ligament, but in the bone at the junction of the pubic and ischiatic components, and is represented by a cartilaginous space in early life and by a thin space in the full-grown animal.

Tracing the progressive disappearance of the limbs in the several members of the class he finds it to commence in the distal parts, that is, in the terminal phalanges, the nail becoming transferred to the proximal remnants or even to parts which are not phalanges. The disappearance of the phalanges culminates in the loss of the digits; commencing at the fifth and going on successively to the first, which is, accordingly, the most persistent. In the shoulder-girdle, which not unfrequently persists when the other parts are lost, the components disappear in the following order, Episternum (Parker's interclavicle), Sternum, Clavicle, Coracoid, Scapula. In the pelvis the several parts fade more uniformly and become blended undistinguishably, first the os ileopectineum and the os puboischium, and then these two with the iliac bone.

Anatomische Studien herausgegeben von Dr C. Hasse, Prosector in Würzburg. Erstes Heft. Leipzig, Verlag von W. Engelmann, 1870, 8vo. ss. 188.

The chief part of this work is occupied by an exhaustive essay on the Comparative Anatomy of the Vertebral Column, more particularly of man and mammals, by Dr C. Hasse and W. Schwarck. It is mainly devoted to descriptive and comparative details, but enters also into the development of the column in the different classes and orders of vertebrates. This is essentially the same in all and, as is well known, takes place from the chorda dorsalis and its sheath, and from the surrounding layers of embryonic tissue; but the place which these respectively take in the several classes is shewn to vary to some extent, the importance of the circumferential layer being greatest in the higher classes. The part contributed by the chorda and its sheath, and chiefly by the latter, is called the "chordal vertebral body," is limited to the vertebral body, and in Fishes, most teleosteans at least, forms the chief part of it. In other vertebrates it plays a minor rôle, the chordal sheath remains non-cellular and is supplemented by a cellular layer, early segmented from the surrounding embryonic strata, and which combines with it to form the "chordal" or "inner" or "true vertebral centre." To this again is superadded an outer layer from the middle stratum of the embryonic tissue, which forms the "outer" vertebral body, and from which also the neural and hæmal arches

and the lateral processes are developed. The formation of these arches and processes, as well as of the outer part of the vertebral body, from the same embryonic substance accounts for their varying position, especially that of the lateral processes, which may be situated upon the body or the neural arches, or both. He shews that the chordal or inner vertebral centrum and the outer part of the vertebral body are in the cartilaginous state distinguished from one another by the more closely set cells and the darker appearance of the latter as compared with the clearer substance and larger cells of the former; yet the two are continuous, and ossification commencing in the one spreads into the other. In the case of the atlas, however, they are and remain more distinct, the inner or chordal vertebral body being represented by that which constitutes the odontoid process of the axis, and the outer part by the anterior portion of the ring of the atlas.

The essay is an excellent work of reference for all who desire to study the vertebral column carefully and to compare the various processes and tubercles in different animals.

The other articles in the number are on the Cupula terminalis of Cyprinoids by Dr C. Hasse: on the nerves of the Serrati postici muscles by Rielander: on the development and anatomy of the Pharynx by Ketel; and on the position of the openings of the Eustachian tubes during development by Kimkel.

Grundzüge der vergleichende Anatomie, von Carl Gegenbaur, Prof. der Anatomie in Jena, Zweite umgearbeitete Auflage mit 319 Holzschnitten. Leipzig, verlag von W. Engelmann, 1870. 8vo. ss. 892. In the eleven years that have elapsed since the first edition of this admirable treatise on comparative anatomy, so much advance has been made that the author has found it necessary to work over the whole subject again and almost to re-write the book. For the German reader it is decidedly the best student's book on the subject, clear, sufficiently full and exact without being tedious. Next to seeing as good a work produced in English, we would gladly see a translation of it for the use of our students.

Compendium der Physiologie des Menschen, von Julius Budge, Professor der Anatomie und Physiologie in Greifswald. Zweite umgearbeitete Auflage. Leipzig, Ernst Julius Günther, 1870.

An immense amount of information in a concentrated form is given in this little book, which must not be regarded as a condensation merely of the author's larger *Lehrbuch der Physiologie des Menschen*, but as an independent work. It would not suffice, even to the student, in the place of a more extended treatise, but will serve as an excellent reminder or primer.

Ornithosauria, Aves and Reptilia from the secondary strata, by Harry Govier Seeley, St John's College, Cambridge, with a Pre-

fatory Notice by the REV. ADAM SEDGWICK, LL.D., F.R.S., Woodwardian Professor, and Senior Fellow of Trinity College, Cambridge. 8vo. pp. 143. Deighton, Bell & Co., Cambridge, 1869.

Ornithosauria, an Elementary Study of the Bones of Pterodactyles, made from the fossil remains found in the Cambridge Upper Greensand, and arranged in the Woodwardian Museum of the University of Cambridge, by HARRY GOVIER SEELEY, of St John's College, Cambridge. 8vo. pp. 135, with ten lithographed plates. Deighton, Bell & Co. Cambridge, 1870.

The expense of printing both these volumes has been defrayed out of the funds of the Syndics of the University Press; and they are the produce of the well-bestowed liberality of the University Syndics and of Prof. Sedgwick furthering the unwearied industry and zeal of Mr Seeley who, as the Professor's assistant, has for years been labouring on this ground. In the prefatory notice, which bears the unmistakeable stamp of the man who has for so many years been one of the glories of Cambridge, and has done so much to throw a halo of popularity over science in the University and the country, the venerable but still ardent Sedgwick, now, he tells us, in his fifty-second year of public service as a Professor in the University, gives an interesting summary of the mode in which the Geological Museum has, from time to time, been augmented under his supervision, and refers especially to the "Coprolite diggings" in the upper Greensand of the neighbourhood of Cambridge, which have "afforded rich spoils to the Museum," and have furnished "a series of specimens of perhaps unrivalled interest in the illustration of the osteological structures and true relations of the great abnormal and difficult sub-class of *Ornithosaurians.*"

The first volume is an Index or Catalogue; and of its value, as the Professor says, "the readers—those especially who read it in our Geological Museum with the arranged specimens before them—will be the best judges." The second volume is a memoir based upon the facts recorded in the first. "When the Professor," Mr Seeley says, "laid upon me his commands to prepare a catalogue of the Museum, it was planned in three distinct works. First, a series of indexes to the specimens in the great divisions in which the Museum is arranged; secondly, a series of memoirs upon the orders and classes of animals concerning which new knowledge is given by fossils in the Museum; and, thirdly, memoirs descriptive of those species contained in the arranged collections which are at present unknown in scientific writings." These two volumes are accordingly examples of the first and second kind of catalogues.

The second volume, or memoir, is of course the more ambitious, although Mr Seeley tempers it with the modesty shewn in the following paragraph.

"The views here urged have however but little novelty. The name Ornithosauria was proposed by the distinguished naturalist Prince Charles Bonaparte in 1838. The group as an order was recognised by Von Meyer in 1830. The affinities of the brain appear to have been detected by Oken, and the bird-like character of the respiratory system was expounded by

Von Meyer. And most of whatever this memoir contains has been already thought or discovered by the German philosophers, who have had the Pterodactyles as fossils of their fatherland, though my own conclusions were arrived at separately and from different materials."

The work consists of:—

1. An introduction, giving an abstract of the views on Pterodactyles held by other writers, p. 1—27; 2. A description of the bones of the Pterodactyles from the Cambridge Greensand, p. 28—94; 3. A summing up and classification.

In Comparative Anatomy Mr Seeley restricts himself to comparing Pterodactyles with *living animals*, his predominant object being to draw physiological inferences from the structures which shall elucidate the classification of the Pterodactyles. Hence before describing the bones, he seeks (p. 25) to determine the *common plan* of the Pterodactyle organism, intimating that in the absence of such a basis any resemblance between the forms of bones in different animals is valueless as evidence of affinity, and as a basis for classification. The unrivalled collection of ornithosaurian remains in the Museum has enabled Mr Seeley to study the brain-cavity and cranial bones of Pterodactyles more fully than any one before him; and he arrives at the conclusion that the brain is essentially a bird's brain, and in so far as it differs from birds it rather approaches mammals than reptiles. In short, the anterior part he considers (p. 86) to resemble the frontal part of the skull of a Dolphin. He also finds the bones *throughout* the skeleton marked with pneumatic foramina, which are usually situated as in birds. As this is limited to the avian class, and is always associated with the bird-lung and heart, he considered that the same inference must be drawn with regard to the pneumatic structure in a pterodactyle bone as would be drawn from the same structure in a bird's bone. And as this avian respiratory system is exactly such as might have been expected from the avian nervous system, the conclusion is "*firmly indicated that the general plan of the most vital and important of the soft structures was similar to that of living birds.*" Yet the "common plan is associated with a diversity of details sufficient to demonstrate that these animals are not birds but constitute a new group of vertebrata of equal value with birds—the sub-class ornithosauria."

A large part of the skeleton of Cretaceous Pterodactyles is here made known for the first time; and each bone is described separately, and then compared with the corresponding part of the skeleton of Reptiles, Birds and Mammals.

Among the more important points is the interpretation of the carpus and distal end of the fore-limb, which (p. 52) he assimilates to that of a bird, shewing it to consist of a proximal carpal, a distal carpal, which in the bird is ankylosed to the metacarpal, and a lateral pisiform. From the fact that the fine hair-like metacarpals of the Pterodactyle are on the pisiform side he argues that "the wing finger was not the little finger, but the index finger, precisely as in birds."

In the pelvis (p. 61) the peculiar anterior bone, often compared

by German anatomists to the os pubis of the crocodile, is regarded by Mr Seeley as a pre-pubic bone comparable apparently with the pre-pubic bones of the lower mammals. He has been able to separate the os innominatum into ilium, ischium and os pubis. And associated with this is a mammalian femur, reminding us in its proximal end of the highest mammals (Pl. VIII. figs. 7 and 8).

The general mode of progression is (p. 105) supposed to have been like to that of a bat; the fore-limbs being longer than the hind-limbs. Two principal groups are formed; one containing the true Pterodactyles; in it the ilium is prolonged far in front of the acetabulum, and the tail is short. The other, containing the long-tailed Pterodactyles, is divided into three lesser groups. The *Rhamphorhynchæ* with toothless fore-jaws and stiff tails, and short hind-legs; the *Dimorphodontæ* with stiff tails, long hind-legs, and large teeth in front of the jaws; and the *Ornithocheiræ* [Cambridge pterodactyles] with long flexible tails, short hind-legs and large teeth in the front of the jaws.

Mr Seeley finally gives a synopsis of species in the Cambridge Greensand; they are all provisionally referred to the new genus Ornithocheirus; and 20 of the 25 are described here for the first time.

An appendix is given of the principal books on the subject, with references to the shelves in the University library where they may be consulted.

Forms of Animal Life, by GEORGE ROLLESTON, D.M., F.R.S., Linacre Professor of Anatomy and Physiology in the University of Oxford, 8vo. Oxford, Clarendon Press, 1870.

One cannot but feel that Professor Rolleston is at the present time one of the most favoured of the sons of science. In the full glow and energy of life, with great ability of mind and body, a ripe well-trained university scholar, glorying in and imbued with the refinement of thought and language of the great of other days and, therefore, sympathising with and congenial to and inspired by the best spirits that are around him, he occupies the noble position of a professorial chair in one of our old universities, which has been endowed with a liberality exceeding that of any similar chair, and for the very purpose of effecting that which he of all men is equal to do, viz. the engendering and maintaining in an ancient seat of learning the spirit of the advancing highest science of the present and harmonizing it with the traditions of the past. The professor of a science in any of our great universities has not simply to teach his science but to set an example in his manner of teaching it, and to show that it can and does so cultivate the reflective no less than the observant faculties of the student as to deserve a place in our educational system and to merit a share of the honours and rewards which the universities are able to bestow.

The work before us is well worthy of such a man in such a post. It is classical, comprehensive, loaded, almost crammed, with know-

ledge, and exact. It is an expression and a resultant of the wise collocation of the Radcliffe Library and the Anatomical Museum. It does not profess novelty either in matter, classification or view. It is not, and does not profess to be, a manual or school-book of comparative anatomy. It does not deal with structure (not even the structure of an eye) or function, but with 'forms,' dispositions and correlations. It supposes and requires a certain amount of knowledge in the reader; but the vast amount of compressed and clearly put information which it gives often in a new and suggestive manner, will render it most valuable, indeed a necessity, to every somewhat advanced student of biology. The distinctive character of the work is stated to consist "in its attempting so to combine the concrete facts of Zootomy with the outlines of systematic classification as to enable the student to put them for himself into their natural relations of foundation and superstructure." The standard and current literature of Europe, of Germany especially, has been ransacked and judiciously appropriated, and nothing seems to have escaped the avidity of the collector, while ample justice is done to all; and abundant references to sources of further information are given in a useful manner at the end of the several descriptions of preparations and plates. It consists of three parts: 1. An Introduction, giving the characteristics of the seven sub-kingdoms—Vertebrata, Mollusca, Arthropoda, Vermes, Echinodermata, Coelenterata, Protozoa—into which with Gegenbaur and other modern zoologists he divides the animal kingdom, but inverting the usual order and beginning with the Vertebrata: 2. a description of preparations of which one or more of each class is given, amounting to fifty in all: 3. a description of plates giving a representation of one or two animals from each sub-kingdom. This plan necessitates some repetition, and may seem at first a little perplexing but, it is hoped, will have the effect of introducing the student in a practical manner to the facts, and induce him to search out and compare facts for himself. "It is recommended that in all cases the study of the described preparation or specimen should precede that of the accounts in the introduction of the Class and Sub-kingdom to which it belongs, and that the study of the descriptions of the plates should be taken up only after the attainment of a considerable familiarity with actual specimens by the practice of dissection." Thus the student will begin with the classification of the preparation of a "common rat, dissected to shew its cranio-spinal nervous axis in its entire length, as well as portions of most of the organs of vegetative life." The preparation, and this is the case with the other preparations described, is in the Oxford museum; and the description is such as would properly form part of the catalogue with some additions. To the Oxford student, therefore, such a description in a separate form would seem to be almost superfluous; and to any other student it would have been much more readily instructive if the plates, given in the third part of the volume, of the same animal dissected after the same method, had been made to harmonize more closely with the description of the preparation. Indeed the wish, here and not unfrequently, recurs that the three parts of

the book had been rolled into one. The individual facts are excellent, but require, as it seems to us, some skilful welding together.

The opening section consists of general considerations respecting the principles of classification and its difficulties, summing up as follows—

"A provisional character however must always attach itself to a greater or smaller part of all our classifications; if they succeed in presenting to our minds the knowledge we possess at the passing moment in a form which gives it compactness as to the past and availability for use in the future, that is all which in the nature of the case they should be regarded as doing, or expected to do, for us. An increase in our knowledge may confirm, but it may, on the other hand, overthrow the most perfectly symmetrical of systems."

It concludes with the following passage which shows reservation on an engrossing topic of the day.

"The theory of evolution with which Mr Darwin's name is connected, asks us to deal with species in their relation to genera and still higher divisions, as we deal with individuals in referring them to particular species, and to believe that the 'secret bond' which colligates species under larger groups, is of the same genealogical character as that which we look for always, and often find in the case of individuals. Many of the peculiarities which attach to biological classification would thus receive a reasonable explanation; but where verification is, *ex hypothesi*, impossible, such a theory cannot be held to be advanced out of the region of probability. The acceptance or rejection of the general theory will depend, as does the acceptance or rejection of other views supported merely by probable evidence, upon the particular constitution of each individual mind to which it is presented. But whether the general theory be accepted as a whole or not, it must be allowed that in the face, on the one hand, of our knowledge of the greatness of the unlikeness, which may be compatible with specific identity; and, on the other, of our ignorance of the entirety of the geological record, the value of the special 'Phylogenies,' or hypothetical genealogical pedigrees, reaching far out of modern periods, are likely to remain in the very highest degree arbitrary and problematical."

The characteristics of the several sub-kingdoms, though comprised in what is termed an introduction, constitute the chief—the most important—part of the volume, and are very fully given. Perhaps the salient features might with advantage have been thrown into stronger relief, while it would have contributed to clearness if some points not distinctly characteristics had been omitted or had been indicated in a different manner, for instance, with regard to Vertebrata that "the segmentation which they exhibit internally does not affect the organs of vegetative life, but is exemplified only in their skeleton, nerves and muscles" (p. xxxii), and that "the digestive tract rarely takes a direct antero-posterior course" (xxxiii): both these characters applying to some invertebrates as well as to vertebrates. Here and there are indications of rather hasty assumption or of statements that need some qualification; thus (p. xxiv) that "the heart of the Vertebrata is a respiratory, whilst that of the Invertebrate animal is a systemic heart," and (p. xlv) that correlated with the absence of valves to guard the entrance of the great veins into the right auricle is "the fact that in mammals the ventricles are

the first and the auricles the second in point of time to contract in each systole", as well as the suggestion that the "'portal system' appears to be formed by the development of *retia mirabilia* in the course of the veins returning from the chylopoietic viscera and the intercalation of the elements of the hepatic glands in the interstices of the plexuses thus formed"; unless, indeed, a similar construction is admitted for all glands and indeed for nearly all the structures of an animal body. The Invertebrates are even better done than the Vertebrates. Professor Rolleston has conferred a great boon upon zoologists, has shewn himself a thorough master of his subject, and may render his work in a future edition still more acceptable by a somewhat different arrangement of the rich stores which it contains.

Handbuch der Lehre von den Geweben des Menschen und des Thiere. Herausgegeben von S. Stricker, Leipzig, 1870.

The third part of this excellent and useful manual of Microscopic Anatomy has just made its appearance. The articles which it contains are the following: the Structure of the small and large Intestines, by E. Verson: the Blood-vessels of the Intestinal Canal, by C. Toldt: the Anatomy of the Liver, by E. Hering: of the Larynx and Trachea, by E. Verson: of the Lungs, by F. E. Schulze: of the Kidneys, by C. Ludwig: of the Supra-renal Capsules, by C. J. Eberth: of the Urinary Bladder and Ureters, by H. Obersteiner: of the Testicles, by la Valette St George: of the Ovary and Par-Ovarium, by W. Waldeyer: of the Skin, Hairs and Nails, by Alfred Biesiadecki, and the beginning of an article on the Serous Membranes, by E. Klein. The work maintains its high character.

Descriptive Anatomy of the Horse and Domestic Animals, compiled chiefly from the manuscripts of the late Thos. Strangeways, by J. W. Johnston, M.D., and T. J. Call, L.R.C.P.E. Edinburgh, 1870.

Horses and Stables, by Colonel F. Fitzwygram, 15th, the King's, Hussars. London, 1869.

Veterinary students in this country have not hitherto had any great choice of text-books to direct them in their anatomical studies. Percivall *On the Horse,* though still used in the schools, is not adapted to the wants and methods of modern anatomical teaching, and Gamgee and Law's *Treatise on the General and Descriptive Anatomy of the Domestic Animals* is an unfinished work, and does not contain more than the osteology, the joints and muscles, with a description of the simple tissues.

The late Professor Strangeways, of the Edinburgh Veterinary College, was well known as a careful, painstaking teacher of anatomy, and since his death the task of editing his manuscript lectures has been undertaken by Dr J. Wilson Johnston, of the Bengal Army, and Mr T. J. Call. These gentlemen have also had access to a manuscript description of the Myology of the Horse, by the late Professor Goodsir, of which they have availed themselves in the

preparation of the manual which they now offer for the use of the Veterinary student.

This manual contains, as might be expected, much good matter, and may be employed by the student as a text-book with much advantage. The work of compilation has not, however, always been performed by the editors with that exactness which is so desirable in a student's manual. We notice, for example, such statements as that in the ox and sheep incisor teeth are developed in the *upper* jaw only; that lymphatics are not present in the brain and eye-ball; that the delicate sheath of a muscular fibre is called *sacrolemma*, &c. Notwithstanding these blemishes, the result apparently of haste in the correction of the press, the book is more complete than any other which the English-reading student has at his command.

Colonel Fitzwygram's treatise is especially devoted to the diseases of horses and the construction of stables, but the book contains many excellent observations on the conformation of the horse, and on the anatomy of the bones, joints, ligaments and teeth. The author is not only a distinguished cavalry officer, but a skilled veterinarian.

Leçons sur la Physiologie et l'Anatomie comparée de l'Homme et des Animaux. By H. Milne Edwards. Paris, 1870.

The second part of the 9th volume of the great work on Comparative Anatomy and Physiology, by the veteran French naturalist, has just been published. It contains chapters on the organs of reproduction of the Echinorynchi, the Trematodes, the Mollusca, and the Zoophytes. The last lecture is chiefly devoted to the consideration of the development of the vertebrate embryo. This part possesses the ease and grace of style and the profound research which has characterized all its predecessors.

Untersuchungen aus dem Institute für Physiologie und Histologie in Graz. Edited by Alexander Rollett, 8vo. pp. 110. Engelmann, Leipzig, 1870.

Contents:—

I. Über Zerzetzungsbilder der rothen Blutkörperchen, by Alexander Rollett.

II. Über den Bau der Aortenwand, besonders der Muskelhaut derselben, by Dr Victor von Ebner.

III. Zur Entwicklung des Knochengewebes, by Dr Constantin Kutschin.

IV. Beiträge zur Physiologie des Darmsaftes, by Dr Alexis Dobroslawin.

V. Beiträge zur Entwicklunggeschichte der Batrachier, by Dr Alexander Golubew.

VI. Zur Kenntniss der Stase des Blutes in den Gefässenenzündeter Theile, by Dr Alex. Ryneck.

REMARKS ON DR DAVIES' PAPER ON THE LAW WHICH REGULATES THE RELATIVE MAGNITUDE OF THE AREAS OF THE FOUR ORIFICES OF THE HEART (*Proc. Royal Soc.* No. 118, 1870). By C. TROTTER, M.A., *Fellow of Trinity College, Cambridge.*

As Dr Davies' paper seems to have attracted a good deal of attention and has been favourably noticed in several Medical Journals, and as I think I can show that the writer fails to establish the law he has enunciated, and that the arguments he uses involve a serious misapprehension of the mode of action of the forces which keep up the circulation, I have put down the following remarks in the hope that they may prove interesting to some readers of the *Journal of Anatomy and Physiology.*

I will first consider how far the facts mentioned by Dr Davies justify the inference which he has made from them. Dr Davies takes the measurements of the mean circumferences of the four orifices as given by Drs Peacock and Reid, and compares with each other the areas of the apertures as deduced by him from these measurements. His remarks upon the result of the comparison are as follows. "No one can observe the close identity of the respective ratios" $\left(\frac{\text{Area of Tricuspid}}{\text{Area of Mitral}} \text{ and } \frac{\text{Area of Pulmonic}}{\text{Area of Aortic}}\right)$ "without concluding that the ratios are really identical, and that the small differences in the calculated results depend entirely upon the impossibility of obtaining absolutely correct measurements of the boundaries of such openings. It is clear therefore that in whatever proportion the tricuspid is larger than the mitral, in exactly the same proportion is the pulmonic larger in area than the aortic orifice."

The results which he obtains from Dr Peacock's measurements are:—

$$\frac{\text{Tricuspid}}{\text{Mitral}} = 1{\cdot}4 \text{ nearly},$$

$$\frac{\text{Pulmonic}}{\text{Aortic}} = 1{\cdot}3 \text{ nearly}.$$

Difference 0·1, or more than 7 per cent.

Dr Reid's figures give somewhat better results, viz.:

	Males.	Females.
$\frac{\text{Tricuspid}}{\text{Mitral}}$ =	1·31	1·36
$\frac{\text{Pulmonic}}{\text{Aortic}}$ =	1·26	1·40
	0·05	−0·04

20—2

In these cases the differences are respectively more than 3 and nearly 4 per cent., and in opposite directions.

Dr Davies' own measurements on individual hearts of different animals gave somewhat varying results.

In two cases out of 10 the agreement is very close; in two there are differences of about 0·8 and 1·6 per cent.; in the rest the per centage varies from 3 to 6·4.

Though such results as these might be looked upon as not inconsistent with the truth of the law enunciated if there were other strong reasons in support of it, they are surely, when taken by themselves, a very insecure foundation for the assertion that "We may fairly conclude that in the healthy human heart, and most probably in the hearts of most animals, the areas of the four apertures bear an exact mathematical relationship to each other."

Moreover, a serious objection may be taken to the calculation on which the comparisons are founded. In computing the areas the orifices are assumed to be circular, the radius is calculated from the circumference, and the area from the radius as so determined. This probably leads to approximately correct results for the pulmonic and aortic orifices, which may be assumed to be approximately circular during the greater part of systole; but the forms of the effective portions of the areas of the atrioventricular apertures are constantly varying during diastole and are probably at no time even approximately circular. It is true that if the simultaneous effective areas of the tricuspid and mitral orifices are at all times geometrically similar figures, these areas will always vary as the squares of the circumferences; and it is only the ratio of the tricuspid to the pulmonic, and the mitral to the aortic orifice which will be different from what it would be if the apertures were circular; but it may be confidently asserted that this is not accurately the case, and it would be rash to say that it is even approximately so; still more to estimate the degree of approximation. But if the figures are not at all times similar, it is impossible to argue from the circumferences to the areas of the orifices. I do not think therefore that the law enunciated by Dr Davies can be looked upon as established by the measurements given except as a rough—perhaps a very rough—approximation.

Dr Davies proceeds to investigate the reasons why the four orifices present such differences of magnitude. His remarks apply mainly to the differences between the pulmonic and aortic orifices, and I now proceed to examine his reasoning.

After dwelling upon the undoubted facts that (1) "The ventricles and auricles act exactly synchronously respectively," and (2) "Equal quantities of blood pass in equal and the same times respectively through any two corresponding orifices of the healthy heart"—he goes on to say, pp. 277, 278 (the italics are Dr Davies'):

"As the left ventricle has to propel the blood to far greater distances, and to overcome obstacles much greater than those found in the pulmonic circulation, the velocity and force of the stream sent from the left must be evidently greater than the velocity and force of

the blood thrown out by the right ventricle"......"As, therefore, the two ventricles contracting with *unequal forces* have to expel *equal quantities* of blood in *equal and the same time* to *unequal distances*, and to overcome *unequal resistances*, the perfect synchronism of the ventricular contractions can be only obtained by an exact graduation of the areas of the orifices of the aortic and pulmonary artery to the muscular forces respectively impressed upon the contents of the two ventricles in systole, and consequently to the velocities of the streams issuing from those chambers. The area of the aortic must be therefore smaller than the area of the pulmonic, and *in such proportion* that the normal average contents (say three ounces) of the left ventricle shall occupy exactly the same time in passing through the aortic as is required by the three ounces of the right ventricle in passing through the pulmonic opening."

Again, p. 281,

"It is evident enough why the blood which has returned to the right heart possesses so small an amount of velocity and momentum. In its passage through the systemic circulation it has encountered and overcome an amount of obstruction which, by the time it has arrived in the right auricle, has deprived it of the greater portion of the velocity and momentum which it had derived from the contractile energy of the left ventricle."

On carefully considering these and other statements of Dr Davies, I can come to no other conclusion than that he maintains

(1) That the energy due to the contraction of the heart by which the resistance to the circulation is to be overcome, exists at the arterial orifices of the heart in the form of *vis viva*[1].

(2) That the velocity and consequently the *vis viva* of the blood depend upon the contractile force of the heart and the area of the arterial openings only.

Now if the heart were contracting in the air and sending out into the air a stream of blood like a jet from a fountain, the distance to which the jet would reach would depend upon the velocity with which it left the orifice and consequently upon the size of the opening. But in the actual case of the heart forcing the blood into a complicated and tortuous system of elastic and flexible tubes the case is quite different: the greater part of the motion will be destroyed as motion, and give rise to an equivalent amount of heat and pressure; the latter in its turn giving rise to motion in other directions.

Moreover the portion of the energy of the heart's contraction which exists as *vis viva* in the aortic orifice is an insignificant portion of the whole. Taking Dr Davies' somewhat extreme estimate of 23·1 inches per second as the velocity at the aortic orifice, it will be found that the energy of this is the same as that which would be produced by the same quantity of blood falling from a height of not quite three-quarters of an inch, and is equivalent to an additional pressure in the aorta equal to that caused by a column of blood three-

[1] Dr Davies explains, p. 283 n., that he uses the popular term momentum where *vis viva* would be more accurate.

quarters of an inch high[1]. The total pressure in the aorta during systole varies a good deal, but we may perhaps put it according to Donders' estimate at 250 mm. of mercury or 3·21 metres or about 10 feet 8 inches of blood, in excess of the pressure of the atmosphere. The real work of the left ventricle is expended in forcing blood into the aorta *against this pressure*: the work employed in impressing upon the blood the assumed velocity of two feet per second is only $\frac{\frac{3}{4}}{128}$, or not quite $\frac{1}{170}$th of the whole. The velocity is that due to the excess of the pressure in the ventricle over that in the aorta. As the blood is forced through the capillaries during diastole the arteries will be able to contract somewhat, and the pressure will diminish to a certain extent, to be raised to its former amount by the influx of a fresh supply of blood during the next systole. The pressure thus produced in the aorta by the contraction of the ventricle will be independent of the size of the orifice between them, except in so far as a contracted aperture will cause a useless resistance and consequent waste of force, thereby diminishing to a certain extent the available power of the heart and the pressure produced in the aorta. Accordingly when there is obstruction at the aortic orifice the pressure in the arteries necessary for the maintenance of the circulation can only be obtained by the expenditure of additional force by the hypertrophied ventricle.

The best experiments on the pressure of the blood in the jugular and other large veins point to a pressure in the large venous trunks within the thoracic cavity less than that of the atmosphere, and this is precisely what we should expect. The tendency of the lungs to collapse through their own elasticity must cause the pressure in the whole cavity of the thorax to be less than that of the atmosphere even during an ordinary expiration; and to this must be added the effect, whatever may be its amount, due to the active dilatation of the heart in diastole owing to the filling of the coronary arteries[2]. There is therefore a difference between the pressure in the aorta and that in the vena cava of something like that due to a column of blood eleven feet high; and it is this difference of pressure, caused itself by the contraction of the left ventricle, and not merely the comparatively insignificant *vis viva* of the blood passing through the aortic orifice, that forces the blood through the capillaries of the systemic circulation.

The actual velocity with which the particles of blood pass the aortic orifice is quite unimportant; all that is necessary is that a certain amount should pass during each systole and a sufficient pressure be maintained in the arterial system.

[1] The height from which a heavy body must fall in order to acquire a velocity v is $\frac{v^2}{2g}$ in this case $\frac{2^2}{2\times 32}$ ft. $=\frac{1}{16}$ ft. $=$ ·75 inches nearly.

[2] First noticed by Brücke, *Sitzungsberichte der Wiener Akad. der Wiss.*, November, 1854. Vol. XIV. p. 345. Afterwards independently by Mr Garrod in this *Journal*, Vol. III. p. 390.

If I am asked, Why then is the aortic orifice smaller than the pulmonic—or, in language more free from hypothesis, In what respect is the smaller size of the aortic orifice advantageous to the animal? I would answer that a sufficient reason is not far to seek.

The arteries contain more blood and therefore are more dilated at the end than at the beginning of systole. If this difference is a considerable fraction of the whole capacity of the arterial system there must be considerable variations of pressure, which would doubtless be in many ways injurious. On the other hand, too large vessels would be unfavourable to economy of space and material, particularly as, for the same pressure, the tension of the walls of a flexible tube varies directly as the diameter, so that the larger the tube the stronger must be the walls.

Now as the systemic arteries, and in particular the large vessels in which the chief dilatation takes place, are much longer than the pulmonic, they need not be so wide in order that the total capacity may be the same, and the same influx of blood produce the same proportionate dilatation in each system. The difference, however, need not be so great as this would seem to imply, as the proportionate difference of pressure caused in an elastic tube by the injection of a quantity of fluid which bears a fixed proportion to the whole capacity of the tube diminishes very rapidly as the radius increases, and consequently the wide pulmonic artery may be dilated considerably more than the narrower aorta without producing a larger proportional increase of pressure; and the whole capacity of the pulmonic and its branches may be considerably less than that of the main arteries of the systemic circulation.

As the ratios of the lengths of the trunks of the systemic arteries to those of the pulmonic may be supposed to be much the same in man and in most of the common quadrupeds, it is not surprising that the diameters of the aorta and pulmonic artery bear a tolerably constant ratio to one another, and the inextensible fibrous ring of the corresponding cardiac orifice obviously need not be larger than the dilated artery, and cannot be smaller without causing unnecessary and therefore wasteful resistance to the passage of the blood.

My final conclusions then are as follows:

(1) There is sufficient reason for the small area of the aortic as compared with the pulmonic orifice, but this has nothing to do with any necessity for impressing a greater velocity on the blood entering the aorta.

(2) There is no proof that the ratios $\frac{\text{Area of Tricuspid}}{\text{Area of Mitral}}$ and $\frac{\text{Area of Pulmonic}}{\text{Area of Aortic}}$ are identical.

REPORT ON THE PROGRESS OF ANATOMY.

By Professor Turner[1].

Osteology.—Wenzel Gruber communicates (*Mém. de l'Acad. Imp. de St Petersb.*, 1869) a memoir on the Anatomy of the Base of the Skull. It contains an account of the *canalis caroticus*, the *foramina lacera anteriora*, the sulci on the petrous bone, the petro-spheno-basilar suture and the small bones developed in that suture.——H. Joseph describes (*Schultze's Archiv*, vi. 182) the Corpuscles and Nerves of compact bone. The corpuscles contain cell protoplasm, in which a single nucleus (rarely two large oval nuclei), filled with numerous granules, is lodged. His observations on the nerves do not refer to those which end in the periosteum, or which pass to the medullary canal along with the nutrient artery, but to nerves which accompany the small vessels that lie in the Haversian canals. He has succeeded in tracing extremely fine nerve fibres into the smallest Haversian canals, in which the fibres possess a varicose appearance. Both in the triton and guinea-pig he figures extremely delicate varicose fibres, which he considers to be nervous, extending into the nuclei of the cell protoplasm lying within the lacunæ.——H. Welcker communicates (*Archiv für Anthropologie*, iii. Heft 3) an elaborate series of tables for calculating the Relations between the length, breadth and height of Crania.——Daniel Wilson communicates (*Canadian Journal*, Nov. 1869) a number of observations on Race Head-forms and their expression by measurements.——The *Prager Vierteljahrsch.*, 1870, p. 19, contains a description by Heschl of Premature Obliteration of Sutures in the cranium of a 7 months' fœtus.

Myology.—In former numbers of this *Journal* (ii. p. 392, iii. p. 196) attention has been directed to the occasional occurrence of a M. supracostalis, an example of which the Reporter figured and described as a Musculus rectus thoracis. In Nov. 1869, W. Turner met with another well-marked specimen, which he now records. It occurred on both sides of a female subject, and was situated under cover of the greater and lesser pectoral muscles. It arose from the osseous part of the upper borders of the 4th and 3rd and outer surface of the 2nd rib by distinct digitations, which blended into a flat muscle, and ascended vertically to be inserted into the upper surface of the 1st rib close to the attachment of the scalenus anticus, from which it was separated by the subclavian vein. Its attachment to the ribs was to the inner side of the origin of the digitations of the serratus magnus.——S. Haughton, in *P. R. S. Lond.*, March 10, 1870, inquires into the Muscular forces employed in

[1] To assist in making this Report more complete Professor Turner will be glad to receive separate copies of original memoirs, or other contributions to Anatomy.

PARTURITION, and concludes that the uterine muscular fibres are capable of rupturing the membranes in every case and possess in general nearly three times the amount of force requisite for that purpose: in the second stage of labour the voluntary action of the abdominal muscles is called into play to aid the expulsive efforts of the uterine muscles. From experiment he has found that the pressure produced by the action of the abdominal muscles equals 38·47 lbs. per square inch.——M. Kulaewsky describes (*Reichert u. du Bois Reymond's Archiv*, 1869, p. 410) the SUBCRURALES AND SUBANCONEI MUSCLES. He considers them not to be independent muscles, but atrophied structures, the former belonging to the quadriceps extensor cruris, the latter to the triceps extensor cubiti.——Wenzel Gruber describes a MUSCULUS BRONCHO-ŒSOPHAGUS DEXTER composed of smooth muscular fibres extending between the right bronchus and the right aspect of the œsophagus.——H. von Luschka describes the ABDOMINAL PART OF THE HUMAN ŒSOPHAGUS (*Prager Vierteljahrsch.*, 1870, p. 9). He considers that neither it nor the orifice into the stomach are situated in the region of the scrobiculus cordis.——In *Reichert u. du Bois Reymond's Archiv*, 1869, p. 589, Luschka describes the MUSCULAR ARRANGEMENTS OF THE HUMAN WINDPIPE, and, at p. 597, the M. RECTUS ARYTÆNOIDEUS of the human larynx.——Anton Schneider gives some additional observations on the MUSCLES OF THE NEMATODES (*Siebold u. Kölliker's Zeitsch.* XIX. p. 284), and in the same Vol., p. 287, H. Grenacher describes the MUSCULAR ELEMENTS OF GORDIUS.

BLOOD-VASCULAR SYSTEM.—Researches on the VENOUS SYSTEM IN THE CRANIUM AND ENCEPHALON, by P. Trolard, appear in *Archives gén. de Médecine*, March 1870. He calls attention to, 1st, cavities containing blood seated on the sides of the superior longitudinal sinus and lodging the Pacchionian bodies; these cavities communicate with the cerebral and meningeal veins, with the venous canals and with the sinus: 2nd, to the presence of a vein which establishes a free communication between the superior longitudinal sinus and the petrous or cavernous sinus. He calls this vein the great anastomotic vein. 3rd, to the termination of the inferior petrosal sinus in the internal jugular vein and not in the lateral sinus. 4th, to a new sinus (inferior petro-occipital) situated on the plane of the petro-occipital suture. 5th, to a vein occupying the anterior condyloid foramen, which receives five veins or sinuses. 6th, to a venous canal (carotid sinus), which surrounds the internal carotid artery from its entrance in the carotid canal until it reaches the cavernous sinus. 7th, to the fact that the vertebral artery is almost completely surrounded by its satellite vein.——Herbert Davies inquires into the LAW WHICH REGULATES THE RELATIVE MAGNITUDE OF THE FOUR ORIFICES OF THE HEART (*P. R. S. Lond.*, March 10, 1870). He concludes that in the healthy human heart, and most probably in most animals, the areas of the four apertures bear an exact mathematical relationship to each other, and consequently if the areas of any of the three openings be known, that of the fourth can be correctly calculated. He expresses the law of relationship as

follows; $\frac{T}{M} = \frac{P}{A}$. The orifices arranged in order of magnitude are tricuspid, mitral, pulmonic, aortic.——V. Feltz communicates (*Robin's Journ.*, Jan. 1870) an account of his experiments into the PASSAGE OF BLOOD CORPUSCLES THROUGH THE WALLS OF BLOOD-VESSELS. He rejects the theory of Addison, which has recently been revived by Cohnheim, that white and red blood globules possess the power of passing through the walls of vessels.——W. Krause gives an account of the RANINE ARCH, and the deep artery of the tongue (*Prager Vierteljahrsch.*, p. 97, 1870).——H. v. Luschka describes (*Reichert u. du Bois Reymond's Archiv,* 1869, p. 424) the arrangement of the VEINS IN THE HUMAN LARYNX.——F. Walkhoff describes (*Henle u. Pfeufer's Zeitsch.* 1869, p. 109) the STRUCTURE OF THE DUCTUS ARTERIOSUS and the mode of its obliteration.

LYMPHATIC SYSTEM.—An abstract of K. Koester's paper on the MINUTE STRUCTURE OF THE HUMAN UMBILICAL CORD is in *Quart. Micros. Journ.* Jan. 1870. He demonstrates a 'plasmatic system' in the cord, his views on the construction of which correspond to some extent with those of Recklinghausen.——G. Schwalbe in *Schultze's Archiv,* VI. p. 1, contributes a memoir of 60 pages on the LYMPHATIC ARRANGEMENTS OF THE EYE-BALL and its appendages. He has succeeded in injecting a number of channels within and around the globe of the eye, which he regards as belonging to the lymphatic system.——C. J. Eberth records some observations on the LYMPH AND BLOOD-VESSELS OF THE BRAIN AND SPINAL CORD (*Virchow's Archiv,* XLIX. p. 48). He considers that the vessels, excepting the finest capillaries, are invested by an external epithelium, which he calls peri-epithelium.

NEUROLOGY.—In our last Report we referred to an abstract of a memoir on the STRUCTURE OF THE CEREBRAL HEMISPHERES by W. H. Broadbent in *P. R. S. Lond.* This author returns to the subject in *Journ. Mental Science,* April, 1870. He describes the crus cerebri, its constitution and relations with the central ganglia and convolutions; the arrangement of the fibres of the thalamus and corpus striatum; the course, and distribution to the convolutions, of the fibres issuing from the central ganglia, whether these have their origin in the thalamus or c. striatum, or have ascended to the hemisphere in the crus; the course and distribution of the fibres which cross from one hemisphere to the other in the corpus callosum; the course of fibres which may pass from the grey matter of one part of the convoluted surface of the hemisphere to the grey matter of other parts. He regards the following as the plan of construction of the hemisphere: the central fibres, including under this term the fibres of the crus and the central ganglia, spreading out are distributed to the convolutions only along certain main lines, or at certain points. They do not as has usually been assumed enter each convolution and form an axial plane connecting the summit of the convolution with the crus; on the contrary there are extensive tracts of convolutions

which receive no central fibres. The fibres of the corpus callosum proceed for the most part to the very same parts of the surface in which the centre fibres end. The intermediate convolutions, which receive no central or callosal fibres, are connected by fibres with the parts of the surface in immediate relation with the crus, central ganglia and c. callosum, and in addition the most distant parts of the hemisphere have connecting fibres, the general direction in both cases being longitudinal: the fibres do not as a rule pass transversely under the sulci from one gyrus to another, but usually run longitudinally in the convolutions from one part of the superficial grey matter to another. The author would have added very materially to the value of his communication if he had referred with greater fulness to the observations of previous writers on the same subject. ——John Cleland describes (*Quart. Micros. Journ.*, April 1870) the minute structure of the GREY MATTER OF THE CEREBRAL CONVOLUTIONS. He reviews the observations of Arndt, Lockhart Clarke and Meynert which have been referred to in previous Reports (II. p. 395, III. p. 450, IV. p. 159). He admits the not unfrequent existence of a superficial layer of nerve fibres, next the pia mater, but is satisfied that in some places these fibres are absent, and that a densely nucleated layer, which he calls the external layer of nucleated protoplasm, is in contact with the pia mater. Extremely fine non-medullated nerve fibres, which come up from the deeper part of the convolution, thread this layer and extend horizontally. Next comes a broader stratum in which the nuclei are more sparing. Some lie in minute pyramidal nerve corpuscles, others are free. Still deeper the pyramidal nerve corpuscles are generally increased in size, and amidst them a defined band of closely aggregated, free, small nuclei, which he calls the nucleated protoplasm of the primary pale band, is seen: this band corresponds with the outer granular layer of Meynert. Immediately beneath this band large pyramidal corpuscles are again seen, together with nerve corpuscles of a more irregular form, which diminish in size as they approach the white substance. With Arndt and others he regards the pyramidal as the typical form of nerve corpuscle in the convolutions; the apex of the pyramid being always directed peripherally, and as he states prolonged into a nerve fibre, which probably always joins the layer of horizontal fibres near the surface: for a short distance at least this fibre is always dark bordered. He inclines to L. Clarke's view that the central processes which arise from the basal part of the pyramidal cell run partly towards the centre of the convolution to be continuous with its fibres and partly to the surface to be continuous with arciform fibres. He is disposed to regard the intermediate or matrix tissue of the convolutions rather as a nucleated protoplasm, than as connective tissue.——A 4th Memoir on the construction of the CEREBRAL CONVOLUTIONS by Rudolf Arndt, which is devoted to the GANGLION BODIES, is in *Schultze's Archiv*, VI. 173. It is principally devoted to the consideration of the question, whether the long peripheral process of the pyramidal nerve-cells branches in its course towards the surface, an arrangement which he had at one time not been able to observe.

Further observations have however satisfied him that it does branch, though not with the regularity which Meynert ascribed to it. He considers that the relations and connections between the nerve fibres and nerve cells in the convolutions are still undetermined, and is by no means prepared to accept the observation of Koschennikoff referred to in our last Report (p. 159), of the continuity of a process from the basal part of a pyramidal cell with a medullated nerve fibre, as expressing the usual arrangement.——H. Hadlich returns to the investigation of the STRUCTURE OF THE GREY MATTER OF THE HUMAN CEREBELLUM (*Schultze's Archiv*, VI. 191). He describes the larger branches of the peripheral process of each corpuscle of Purkinje as giving origin to extremely delicate thread-like fibrils, some of which are short and do not branch, whilst others branch more or less frequently. His paper is specially devoted to the consideration of the mode of termination of the branching processes of the corpuscles of Purkinje, and he considers that he has shown that the extremely delicate fibrils in which the branching processes end, after they approach the surface of the grey matter, form wider or more pointed arches, and then pass back from the surface towards the rust-coloured layer of the cerebellum. He recognizes also a system of supporting fibres (*Stütz fasern*) as described by Bergmann and F. E. Schulze, derived apparently from the inner surface of the pia mater, which pass vertically into the grey layer of the cortex. He summarizes his results as follows: from the white core of the cerebellar leaflets nerve fibres pass into the rust-coloured layer, where they divide, and then pass into the central basal process of the corpuscles of Purkinje, one fibre to each cell (see last Report, p. 158). From each cell a very abundant branching of the peripheral process occurs, and the finest fibres derived from these branches arch and pass backwards as recurrent fibres to the rust-coloured layer. Hence both a centripetal and centrifugal system of conducting structures exist in the cortex of the cerebellum.——H. von Luschka describes (*Robin's Journal*, Jan. 1870) the DISTRIBUTION OF THE NERVES IN THE HUMAN LARYNX.——A. Lindemann describes the TERMINATION OF THE NERVES in the LARYNGEAL MUCOUS MEMBRANE (*Henle u. Pfeufer's Zeitsch.* 1869, p. 148).——F. Bidder records (*Reichert u. du Bois Reymond's Archiv*, 1869, p. 472) observations on the SPLANCHNIC NERVES and CŒLIAC GANGLION.——Observations on the PACINIAN BODIES IN THE APES are made by M. G. Nepven (*Ann. des Sc. Nat.* XII. 1869, p. 326). He examined them in *Troglodytes niger*, *Cercophithecus mona*, *Cynocephalus sphinx* and *Cebus*. They possess the same general structure as in man, but they are smaller and less numerous. *In cercopithecus, cynocephalus* and *cebus* the nerve fibre exhibits flexuosities, which are not present in man and the chimpanzee.——Jas. Tyson by pursuing the mode of investigation recommended by Lionel Beale has traced out (*Quart. Mic. Journ.* Jan. 1870) the DISTRIBUTION OF NERVES to the vessels of the connective tissue in the hilus of the pig's kidney, and has described ganglia found in connection with these nerves.——S. Mayer (*Schultze's Archiv*, VI. p. 100) offers some

remarks on the NERVES OF THE SALIVARY GLANDS.——C. J. Eberth describes his observations on the ENDING OF THE NERVES OF THE SKIN (*Schultze's Archiv*, VI. p. 225). His observations agree in the main with those of Langerhans (*Report*, III. 452), for he recognizes fine nerve fibres passing from the nerves of the cutis into the deeper layer of cells of the cuticle, and also star- and spindle-like cells in the cuticle, which perhaps may be nervous structures, though he has not traced any connection between them and the nerve fibres. ——H. Lipmann describes (*Virchow's Archiv*, XLVIII. 218) the ENDING OF THE NERVES in the proper tissue of the CORNEA and in its posterior epithelium. He considers that he has seen the nerves of the corneal tissue ending in the nucleoli of the corneal corpuscles; and that the nucleoli of the cells of the posterior epithelial layer stand in a similar relation to the finest nerve fibres.——Carl Meyer conducts an experimental enquiry (*Henle u. Pfeufer's Zeitsch.* 1869, p. 164) into the DISTRIBUTION OF THE NERVES IN THE HIND LIMBS OF THE FROG.

EYE-BALL.—J. Dogiel investigates the MUSCULUS DILATATOR PUPILLÆ in mammals, men and birds (*Schultze's Archiv*, VI. p. 89). He recognizes both a sphincter and dilator of the pupil in all. In birds the sphincter is more developed than in man and mammals. In some birds there are two dilator muscles, one which occupies the entire surface of the iris, the other which traverses obliquely from before backwards the entire thickness of the iris. In man and mammals the sphincter and dilator muscles are formed of smooth fibres, in birds of transversely striped. The ciliary ring serves as the fixed point for the dilator muscle.——D. Iwanoff examines (*Robin's Journal*, March, 1870) into the different states of the CILIARY MUSCLE in the eye-ball in myopia and hypermetropia.—— Max Schultze (*Archiv*, v. 379) communicates a memoir on the ENDING OF THE NERVES IN THE RETINA. After some observations on the probable mode of action of light on the retina he describes the relation existing between the nerve fibres and rods in the retina of the Cephalopoda. He shows that the rods both of the human eye and that of many other animals consist of two different substances, viz. of little plates united by a connecting material of a different nature. These two substances he regards as being of importance in explaining the manner in which light affects the nerve fibres. In the Cephalopods the rods do not become continuous with the nerves, but the latter run either in canals formed by the former, or they lie on the surfaces of the latter. Where pigment exists it follows the nerve fibres closely and encloses them in the canals just mentioned. In many Cephalopods the light can only affect the nerve fibres through the intervention of the rods. In them the pigment is of importance in preventing the light having access to the nerves except through the medium of the rods and cones. The author then goes on to describe with great minuteness the structure of the retina in the Triton and in Man. In the former he denies the existence of any central canal in the rods. In the latter he describes the rods

as being grooved longitudinally on their surface. These grooves are from 14 to 16 in number in the cones, whilst in the rods they are from 8 to 12 in such a piece as can be seen. When both rods and cones are removed there is to be seen projecting from the surface of the external limitary membrane a number of small threads which are seen to be arranged in circles round the bases of the rods and cones. These threads seem to be the ends of the fibrils of the optic nerve, which lie in grooves on the surface of the rods and cones, and thus agree in their arrangement with what is known to be the case in the Cephalopods. These fibres seem to be derived from the fibres which are well known as belonging to the rods and cones, splitting up as they approach the latter. This arrangement brings the structure of the retina into relation with that of the ear, nose and tongue, and explains cases as those reported by Krause, where there was atrophy of the optic nerve fibres, but persistence of the rods and cones. The structure just described by the author was found to obtain in birds, reptiles, fishes and mammals.

MALFORMATIONS.—E. Goujon describes and figures (*Robin's Journal*, VI. 599) a case of imperfect BISEXUAL HERMAPHRODISM in the human subject.——T. B. Peacock records (*Trans. Path. Soc.* XX. p. 61) a case of MALFORMED HEART where there was atresia of the orifice of the pulmonary artery, and where the aorta communicated with both ventricles; and at p. 87, a second case of a closely similar character.——In the same Vol. p. 88, W. Hickman describes a heart where the auricles and aorta were transposed, the pulmonary artery was absent, the foramen ovale patent, the ventricles communicated with each other; the principal viscera were laterally transposed, and cyanosis existed.——The same author also records, p. 418, a case of PERSISTENT VITELLINE DUCT in a female child æt. 4 months.——G. C. Coles describes, p. 417, a man æt. 20, in whom both UPPER LIMBS were MALFORMED.——T. P. Pick, p. 423, describes a case of DOUBLE MONSTROSITY, where the twins were joined along the whole length of the sternum and as low down as the umbilicus.——A case is recorded by Dr Eggel (*Virchow's Archiv*, 1870, XLIX.), of a young man with a MALFORMED THORAX, in whom a deep depression existed in the thoracic wall corresponding to the lower sternal region.——In the same Vol. p. 143, M. Fränkel describes a dead-born child which had TWO DISTINCT HEADS and necks connected with a single trunk.——In the same Vol. p. 348, N. Tolmatschew describes the case of a new-born boy where the VESICULA PROSTATICA was enormously DILATED, the urethra with semilunar valves at its vesical orifice, and the ureters dilated.

EMBRYOLOGY.—W. C. M'Intosh describes and figures the early stages in the DEVELOPMENT OF PHYLLODOCE MACULATA in *Annals Nat. Hist.* August, 1869.——Ernst Hæckel publishes in *Verhand. Utrecht Genootsch van Kunsten en Wetensch.* 1869, a prize Memoir on the DEVELOPMENT OF THE SIPHONOPHORA, in which the genera *Physophora*, *Crystallodes*, and *Athorybia* are especially considered.——J.

Knoch records observations (*Robin's Journ.* Jan. 1870) on the DEVELOPMENT OF BOTHRIOCEPHALUS.——M. G. Balbiani relates his researches on the DEVELOPMENT AND MODE OF PROPAGATION OF STRONGYLUS GIGAS. ——E. Claparède and E. Mecznikow communicate a Memoir (*Siebold u. Kölliker's Zeitsch.* XIX. p. 163) on the DEVELOPMENT OF CHÆTOPODS: at p. 244, H. A. Pagenstecher records a new method of DEVELOPMENT IN SIPHONOPHORA: and on p. 281, F. Rætzel relates his preliminary researches into the DEVELOPMENT OF LUMBRICUS and NEPHELIS.

COMPARATIVE ANATOMY AND MORPHOLOGY.—In his introductory lecture to the course of Hunterian Lectures, W. H. Flower points out the bearings of the evolution theory of Darwin on the study of morphology, and of classification. "A true classification viewed by the light of the derivative hypothesis is nothing more or less than an expression of the actual amount of affinity between different objects." ——This aspect of the Darwinian theory has been worked out in connection with the CLASSIFICATION OF INSECTS by Anton Dohrn (*Stettiner Entomologische Zeitung*, 1870). He divides the eggs of insects into ectoblastic and endoblastic ova. In ectoblastic eggs the yolk is surrounded entirely by a layer of embryonic cells, which layer thickens at one spot, and this thickening proceeds over the greater portion of the periphery of the yolk, which is thus entirely surrounded by it. In endoblastic eggs the thickening of the layer of embryonic cells does not extend over the periphery of the yolk, but grows into its centre, so that the *Keimstreif* is enclosed by the yolk. Taking this as the basis of classification he points out that the seven present families of insects, consist of very heterogeneous elements, and that an arrangement into two classes, ecto- and endo-blastic insects, each of which again may be subdivided into smaller groups, is to be preferred.——In a former Report (III. 205) attention was directed to an important Memoir by Kowalevsky on the DEVELOPMENT OF THE ASCIDIAN MOLLUSCS, in which the presence of a chorda dorsalis and other vertebrate characters were described in the ascidian larva. A series of observations has now been conducted by C. Kupffer (*Schultze's Archiv*, VI. 115), on the DEVELOPMENT OF ASCIDIA CANINA, which supports the observations of Kowalevsky. The free swimming larva in its early stages of development shows many points of resemblance to the vertebrate embryo. A chorda dorsalis has on its upper or convex side a nervous axis, whilst its inferior or concave aspect is in relation to the alimentary canal. After the embryo has lost its free state, and become attached, it retrogrades from its vertebral affinities, the chorda &c. degenerate and disappear, and the animal gradually assumes the characteristic ascidian structure.——George Gulliver describes the MUSCULAR SHEATH OF THE CARDIAC END OF THE ŒSOPHAGUS of the AYE AYE (*Chiromys Madagascariensis*), (*Proc. Zool. Soc.* April 22, 1869). Not a single striped muscular fibre could be found in the entire thickness of the œsophagus but only smooth fibre, so that the structure corresponds with that in other Quadrumana and not with that found in Rodentia.——An abstract of a paper by Richard Owen on the DIPROTODON AUSTRALIS is in *Proc. Roy. Soc.* Lond. Feb. 3, 1870.

——E. Perrier communicates his researches (*Ann. des Soc. Nat.* XII. 1869, p. 197), on the PEDICELLARIA AND AMBULACRAL ARRANGEMENTS OF THE ECHINODERMATA.——F. E. Schulze gives an account of the SENSE ORGANS connected with the LATERAL LINE in Fishes and Amphibia (*Schultze's Archiv*, VI. p. 62).——An elaborate Memoir ON THE STRUCTURE OF THE BRITISH NEMERTEANS, and some NEW BRITISH ANNELIDS, by W. C. M'Intosh, is in *Trans. Roy. Soc. Edinb.* 1869. The Memoir is illustrated by sixteen beautifully executed plates.——Alex. Macalister describes (*Annals Nat. Hist.* March, 1870) the MYOLOGY OF THE WOMBAT (*Phascolomys Wombata*), and the TASMANIAN DEVIL (*Sarcophilus ursinus*).——Jas. Hector gives a list of the BONES OF SEALS AND WHALES in the Museum at Wellington, New Zealand (*Ann. Nat. Hist.* March, 1870). He refers them to *Stenorhynchus leptonyx*, *Arctocephalus leonina*, *Balæna marginata*, *Globiocephalus macrorynchus*, *Berardius arnuxii*, *Lagenorynchus clanculus*, and a rorqual which Dr Gray believes to be the *Physalus Antarcticus*.——M. Marey gives an account (*Ann. des Sc. Nat.* XII. 1869, p. 49) of his researches into the MECHANISM OF FLIGHT IN INSECTS AND BIRDS. The Memoir is very elaborate and is illustrated by a number of drawings of ingenious pieces of apparatus, by the aid of which the investigation has been conducted. The same subject was enquired into a few years ago by J. B. Pettigrew, and an elaborate and beautifully illustrated Memoir by him was published in *Trans. Linn. Soc.* 1867. M. Marey however makes no mention of these researches.——C. J. L. Krarup-Hensen has also published a pamphlet, *Copenhagen*, 1869, on the FLIGHT OF BIRDS, BATS, AND INSECTS.——A Memoir on the SKELETON OF THE LIMBS OF ENALIOSAURIER, by C. Gegenbaur is in *Jenaische Zeitsch.* V. p. 332. He endeavours to fix the homologies of the different bones composing the paddles of these animals. He thinks that the type of limb is to be found in that of the Selachia. He argues from data given in previous papers of his own (*Untersuchungen Z. Ver. Anatomie*), that "the fundamental arrangement of the skeletal portions of the limb in Ichthyosaurus is deducible from the same conditions which lie at the foundation of the composition of the paddles of Selachia," and concludes from the arguments contained in the present paper that the paddle of Ichthyosaurus retains much which is characteristic of low development, but nevertheless that all the elements of the limbs of higher forms are contained in it, and that the last overcomes the first inasmuch as the points of agreement with the limbs of the higher forms are more important than the points of difference. With reference to the Plesiosaurus he objects to the special homologies of the different bones as given by Owen, and points out that the metacarpal bones of the four fingers in Plesiosaurus are (from the facts he points out) formed in the higher animals so as to assume the form of carpal bones. He is of opinion that the small bones on the ulnar side of the limb of this reptile must be regarded as members of a ray, of which in the higher animals the pisiform is the only representative. He concludes lastly that the Plesiosaurus descended earlier than the existing amphibia from the vertebrate parent stock, and that both it

and the Ichthyosaurus must be regarded as belonging to types far removed from each other, as also from existing amphibians. CONTRIBUTIONS to the ANATOMY AND CLASSIFICATION OF THE DINOSAURIA were made to the Geological Society, Nov. 10, 24, 1869 (*Quart. Journal*), by T. H. Huxley. He describes *Hypsilophodon Foxii*, a new Dinosaurian from the Wealden of the Isle of Wight. He advances additional evidence of the affinity between the Dinosaurian reptiles and birds: he defines the group of Dinosauria, establishes the order Ornithoscelida to include the Dinosauria and the Compsognatha, points out the affinities of this order with other reptiles and with birds, and concludes with an account of the Dinosauria of the Trias.——For some time past W. Peters has been communicating to the *Monatsberichte* of the Berlin Academy papers on the auditory ossicles in reptiles, more especially in the crocodiles, in which he argues against the doctrine of Reichert and Huxley, that the auditory columella of the lower Vertebrata does not answer to all the ossicles of the mammalia, but only to the stapes, the incus being represented by the quadrate bone, the malleus by the articular, and considers that the ossicula are completely represented by the columella, while the tympanic is the homologue of the os quadratum. In consequence of these papers T. H. Huxley has re-investigated the subject (*Proc. Zool. Soc. London*, May 27, 1869), and dissents from Peters's conclusions. He states that in the crocodile no connexion exists between the articulare and stapes, but a very close connexion exists between the stapes and a cartilage which distinctly represents the upper end of the hyoidean arch, which facts suggest that these parts are modifications of the skeleton of the 2nd visceral arch, a suggestion which becomes a certainty when *sphenodon* is examined, in which the supra-stapedial cartilage is the proximal end of the hyoidean arch, while the stapes and its appendages have nothing to do with the mandibular arch. In the mammal the proximal end of the hyoid arch is in nearly the same state as in the crocodile except that 1st, there is an articulation between the supra-stapedial part and the stapes; 2nd, the extra-stapedial portion of the stapes is not distinguishable and the stapes has lost its connexion with the tympanic membrane; 3rd, the supra-stapedial is ossified and has become the incus. In the course of his enquiry he has been led to modify his former opinion as to the homology of the malleus and the incus. The conclusions he has reached he embodies in the following tabular form:

Mandibular Arch.

I. Mammal. Malleus—Meckel's cartilage.
II. Sauropsidan. Quadratum—Articulare—Meckel's cartilage.
III. Teleostean. Metapterygoid and Quadratum—Articulare—Meckel's cartilage.

Hyoidean Arch.

I. Mammal. Incus—Stapes—Stapedius, Styloid, Hyoid cornu.
II. Sauropsidan. Supra-stapedial—Columella auris, Hyoid cornu (*Sphenodon*).
III. Teleostean. Hyomandibular—Stylo-hyal, Hyoid.

W. Peters returns to the subject in a paper in *Monatsbericht*, 17 Jan. 1870. He lately examined a fœtal crocodile, and found without difficulty the canal described by Huxley between the articular portion of the lower jaw and the quadrate bone, as well as the air-cells in the latter communicating above with the tympanum. From the posterior end of the external hatchet-formed process of the malleus proceeds a thin bent cartilaginous thread, which becoming thicker and flatter, and then pointed, is lost in the direction of the foramen pneumaticum. A continuity between the columella and cartilage of the malleus he must decidedly oppose, for the latter (the extra and supra-stapedial cartilage of H.) terminates abruptly with its short base by a regular convexity towards the external end of the columella; the interpretation of which as a rudimentary incus Peters has long since given up after repeatedly convincing himself of its absence in birds. That an organ as the incus, which in the mammalia gradually decreases from the higher to the lower, and in the birds has totally disappeared, should again appear so large in the crocodiles, has little probability. Huxley has in the Echidna described the large muscle of the malleus, and has shown that in platypus the stapedius is wanting. Peters states that the relation of the incus to the malleus in the Echidna proves still more the most intimate relation of the two bones, yet he says that Huxley advances on the contrary the relation between the incus and stapes as more intimate, and notwithstanding the stapedius muscle has already quite disappeared in platypus, the muscle which appears in the crocodiles is not the muscle of the malleus but the stapedius; or rather, as Huxley regards the large cartilage indicated by Peters to be the malleus, as the incus springing out of the stapes,—an entirely new muscle of the incus. In one stage of *biporcatus* the cartilage of Meckel as far back as that portion which is placed in the articulare is solid. In an older embryo of *vulgaris* the cartilage of the articulare is still continuous with the anterior end of Meckel's cartilage. A cavity is formed already in it, and this cavity is connected by a short canal to the hollow os quadratum.

ERRATUM.

Page 133, line 23, *for* "This rib 8 inches long and 4 at its widest part," *read* "This rib 0·8 inch long and 0·4 inch wide at its widest part."

REPORT ON THE PROGRESS OF PHYSIOLOGY, from 1st August, 1869, to 1st April, 1870. By THOMAS R. FRASER, M.D., F.R.S.E., F.R.C.P.E., *Assistant Physician to the Royal Infirmary, Edinburgh*, and WILLIAM RUTHERFORD, M.D., F.R.S.E., *Professor of Physiology, King's College, London*[1].

DR FRASER'S REPORT.

Physiological Action of Medicinal and Poisonous Substances.

CARBONIC ACID.—Dr Leven publishes (*Archives de Physiologie*, No. 1, 1870, p. 177) the following results of an investigation into the physiological action of carbonic acid. 1. Whether respired in the pure state or mixed with a certain proportion of air, it does not excite any convulsive action. 2. After absorption, it acts directly on the muscular fibres of the heart, modifying their chemico-physical and physiological properties, and destroying their contractibility. 3. It has no action on the blood-globules, nor on the blood-vessels. 4. It "stupefies" the brain and the medulla oblongata: the stupefaction of the brain manifesting itself by suspension of its functions—of intelligence, sensibility and voluntary movement; that of the medulla oblongata, by arrest, succeeding impairment, of the respiration and circulation. 5. The reflex function of the spinal cord and the functions of the nerves are unaffected by this gas, and the contractibility of the muscles is likewise uninjured. 6. By the suspension of the functions of the brain and of the medulla oblongata a condition of death-like sleep is produced, which can be removed only if it has existed for a certain limited period, varying with the species and age of the animal; and oxygen is the only substance that is capable of awakening the brain and medulla oblongata from this death-like sleep. 7. If, by a proper mixture of carbonic acid and air, death is gradually produced (for example in about half-an-hour) the temperature of the body diminishes nearly two degrees centigrade, and diabetes supervenes. Sugar is found in large quantity in the blood and viscera; and in the rabbit the urine yields nearly 10 grammes of sugar to the litre. 8. Oxygen and carbonic acid produce contrary effects. The former excites the cardiac contractions, reddens the blood-globules, gives life to the brain-cells, stimulates the medulla oblongata, and acts peculiarly as a nourishing and vivifying gas; the latter, on the other hand, is a true poison, it

[1] In order to assist in making this Report as complete as possible, the authors will be glad to receive copies of original contributions to physiology. Papers on the *Physiological Action of Medicinal and Poisonous Substances* to be sent to Dr Fraser, the University, Edinburgh. Those on *Physiological Chemistry* to Dr Gamgee, Royal College of Surgeons, Edinburgh. Those on other physiological subjects to Dr Rutherford, King's College, London.

is a gas that kills by destroying the physiological properties of the heart, brain and medulla oblongata, and it is necessary that it should be continually eliminated. Dr Leven's experiments were made on rabbits, cats and guinea-pigs; to whom the gas was administered either pure or mixed with definite proportions of atmospheric air, and either by inhalation during ordinary respiration or by introduction into the trachea through an artificial opening.

CHLOROFORM.—We abstract the following interesting observations on the action of chloroform from Professor Paul Bert's *Leçons sur la Physiologie Comparée de la Respiration*, 1870 (p. 137). The numerous authors who have written on the action of anæsthetics are not agreed as to the influence these substances exercise on the colour of the blood. According to some, the blood retains its normal colour; according to others, it becomes black in the veins, and even in the arteries its hue is much darkened. The latter opinion has originated the idea that the anæsthesia of chloroform is in reality a state of asphyxia. When an animal is submitted to the influence of an anæsthetic a period of excitement is in the first place produced. It has been already shown that this excitement, in the case of animals with low intelligence, is due to an irritation of the facial and buccal mucous membranes by the anæsthetic vapours; in animals of higher intelligence, such as man and certain dogs, it is, however, also due to delirium, originating undoubtedly in abnormal cerebral sensations (see *Journal of Anatomy and Physiology*, Nov. 1867, p. 185). It is during this period, when violent movements occur, that the venous blood becomes black; and if it last long, and especially if it be accompanied with embarrassed respiration, the colour of the arterial blood may also become dark. Succeeding this stage of excitement, however, is one of resolution, during which the arterial blood becomes bright red, and even the venous blood may now be of a marked rose colour. If the quantity of chloroform is gradually increased the animal dies; in which case asphyxia and not syncope has been caused, and the arterial blood assumes a black hue such as that of ordinary asphyxia. Bert has analysed the blood drawn during the period of complete chloroform resolution, and contrasted the results with blood drawn before the administration. In one case, before anæsthesia, the blood contained, in 100 parts, 7·3 per cent. of oxygen, and during the period of resolution 12·4 per cent. In another case, 15·1 per cent. of oxygen before, and 18 per cent. during resolution. Thus, during the *uncomplicated action* of an anæsthetic, the blood is more rich in oxygen than during the normal condition. It is therefore erroneous to regard anæsthesia as a state of asphyxia.

OPIUM ALKALOIDS.—It will be remembered that Dr S. Weir Mitchell published last year some remarkable observations regarding the insusceptibility of pigeons to the poisonous action of opium (see *Journal of Anatomy and Physiology*, May, 1869, p. 479). These observations have been extended in a second paper of great

interest (*American Journ. of the Med. Sciences*, January, 1870); in which the following conclusions are stated:—1. Birds (namely ducks, chickens and pigeons) are never poisoned by crude opium, or its aqueous extract, or *acetum opii*, given internally; while the salts of morphia must be given in enormous doses to produce fatal effects when given in the same manner. 2. Morphia salts, used hypodermically in excessive amounts, never cause sleep or stupor, but act as excitants upon the motor centres. In some instances, the spasms are tetanoid in character; and in the duck they approach nearest to the typical strychnia spasm. 3. Thebaia is a tetanizing agent, only inferior in energy to strychnia and brucia. 4. Narcotina, almost inert in man, destroys birds, when employed hypodermically, in doses of from 2 to 7 grains. 8. Codeia is a fatal convulsing agent in birds. 9. Meconin causes emesis when given internally, and is harmless when placed under the skin. 10. Narceia has no perceptible influence except to disturb slightly the respiratory function. 11. Cryptopia in doses of $\frac{1}{8}$ to $\frac{1}{2}$ grain has no effect. 12. None of these agents cause sleep in the pigeon, duck or chicken. Dr Mitchell concludes his paper with some very important remarks in explanation of the differences between the action of the opium bases in various classes of animals; and we are glad to find that his explanation is founded on principles which closely agree with those we stated in connection with his previous communication[1].

ABSINTH.—The dangers of prolonged indulgence in absinth-drinking have been pointed out by many writers, and, recently, experiments have been made to ascertain the nature of the poisonous action of this substance. Drs Magnau and Bouchereau add some facts to what is already known (*Comptes Rendus*, 5 Avril, 1869). They administered the poison to dogs, cats, rabbits and guinea-pigs, and found that convulsions of an epileptic character were quckly produced. These convulsions, they further show, are caused by some component part of the *Artemesia absinthium*, and not by the alcohol in which it is dissolved.

STRYCHNIA.—In an elaborate and ingenious paper Professor Vulpian (*Archives de Physiologie*, No. 1, 1870, p. 116) examines the arguments on which Professor Bernard founds the opinion that strychnia and curara are poisons that possess opposite physiological actions, the former acting primarily on the sensory nerves and the latter on the motor. His arguments are, however, chiefly directed against the corollary from these views, which Professor Bernard has so frequently and eloquently enunciated; namely, that by proving that the poison of the motor nerve fibre is not the poison of the sensory nerve fibre it is clearly shown that the motor and sensory nerve fibres are physiologically distinct. From the results of a large number of experiments, Professor Vulpian considers himself justified in maintaining that as neither strychnia nor curara can be regarded as in any special manner the poison of either the sensory or motor nerve

[1] *Journal of Anatomy and Physiology*, May, 1869, p. 480.

fibres, the study of the action of those two poisons does not assist us in establishing the existence of any real difference between the physiological properties of motor nerve fibres and the physiological properties of sensory nerve fibres. At the same time, Vulpian coincides in the opinion of Van Deen, Marshall Hall, Brown-Séquard, Martin-Magron and Buisson, and others, that strychnia primarily affects the grey matter of the spinal cord; and in the generally received opinion that curara primarily acts by suspending the conductivity of the motor nerves. The latter effect he attributes to the interposition of some unknown obstacle between the motor nerve fibre and the muscular fasciculus with which it is connected, and not to an action directly exerted on the termination of the motor nerve fibre itself.

CURARA.—In an elaborate memoir (*Ueber die Pharmakologische Gruppe des Curarins*), Buchheim and Loos describe a number of experiments with various substances possessing a curara-like action. Besides curara and its alkaloid, they examined the action of methyl-delphinium and its sulphate, of sulphate of methyl-strychnium, iodide of methyl-atropium, iodide of methyl-quinium, sulphate of ethyl-strychnium and of ethyl-brucium, iodide of methyl-brucium, sulphate of methyl-quinium, sulphate of methyl-cinchonium, iodide of amyl-cinchonium, cotarnin, amyl-veratrium, sulphate and iodide of methyl-nicotium, sulphate and iodide of ethyl-nicotium, and extracts of echium and anchusa. All these substances were found to paralyse the terminations of the motor nerves, though some of the last-mentioned did so to only a feeble extent. There can be no doubt that the list might be very considerably extended, but it is sufficiently large to allow of several generalizations. The authors point out, as has been already done by Brown and Fraser, that as far as the constitution of these bodies is known they are all ammonium bases. Further, we do not as yet know any substance acting like curara which possesses a different constitution. Hence it follows with some probability that curarina and cynoglossine (a substance that paralyses the motor nerves) may belong to this series of bases. In support of this the authors mention that even the iodide of tetra-methyl-ammonium has been shown by Brown and Fraser to exhibit the action of curara. This elective action of the ammonium bases can only be explained as the result of a chemical action on the motor nerve terminations (or on some structure interposed between these terminations and the muscular fasciculi. F.). Buchheim and Loos have likewise shown that these substances modify the elasticity of muscles in such a way that the curve drawn by the myographion is lengthened.——Professor Vulpian devotes a short paper (*Archives de Physiologie*, No. 1, 1870, p. 171) to prove that the abolition of voluntary movements in mammals poisoned by curara is not caused by impairment in the vital conductivity of the spinal nerves. He adduces an interesting experiment in support of this opinion.

THE ACTION OF CERTAIN ALKALOIDS AND OF BROMIDE OF POTASSIUM ON THE HEART AND BLOOD-VESSELS OF THE FROG.—Of two papers on the above subject by Dr Frederick B. Nunneley, the first (*Proceed. Roy. Soc. of Lond.* June, 1869, p. 46) describes the results of experiments with atropia, digitalin, and aconitia. The author thinks that atropia exerts no action on the blood-vessels of the frog, while its action on the heart is neither considerable nor energetic, a progressive weakening of its power being the most prominent visible effect. Digitalin however acts with great energy on the heart, throwing it into violent and disorderly contractions, which soon end in a cessation of movement. The exact changes that are observed in the nature of the cardiac contractions are minutely described, and agree in all essentials with those already described by Kölliker, Pélikan, Hilton Fagge and Stevenson, Vulpian and others. Aconitia has also a very marked action on the heart, "the opposite of that of digitalin;" but neither this alkaloid nor digitalin produce any effect on the vessels of the web, whether directly applied, or injected under the skin. In a second paper (*Practitioner*, December, 1869, 347), the effects of strychnia, veratria, morphia, nicotia, conia, and bromide of potassium are similarly examined. Of these alkaloids, veratria alone exerts a marked action on the heart; an action resembling that of digitalin, and warranting its classification along with it in the well-recognised class of the *cardiac poisons*. Bromide of potassium, in large doses, quickly arrests the heart's contractions in diastole; in small doses the frequency of the contractions is gradually diminished, while "at first, at the end of a systole, the blood is driven to one part of the ventricle, which becomes, with each contraction, a projecting red spot." In direct contradiction to numerous previous observers, Dr Nunneley asserts that "no effect is produced on the arteries of the web, either by the local application of the bromide, or by its injection under the skin."

TOBACCO.—In discussing the principles of the treatment of asthma by tobacco, Professor Sée (*Bulletin Génér. de Therapeutique*, 15 Novembre, 1869, p. 385) mentions several important facts in relation to the physiological action of this remedy. One of its leading characteristics is the readiness with which tolerance to its action may be produced. Many observations have established this, among the most striking of which is that of Professor Traube, who found that while a small dose of nicotia given for the first time to a dog caused marked cardiac symptoms, the same dose administered a few hours afterwards was completely inert. Sée points out that, in reference to their power of producing tolerance, medicines may be divided into three groups: in the 1st, tolerance is decidedly produced, often almost immediately, as happens conspicuously with tobacco, and less so with opium, belladonna, Indian hemp and arsenic; in the 2nd, in place of tolerance, cumulative effects result, as with digitalis and strychnia; and in the 3rd, the effects are exactly proportional to the dose given, however frequently it may be repeated, as occurs with bromide and cyanide of potassium, &c. In reference

to the influence of tobacco-smoking on the mental activity, it is asserted that a moderate indulgence produces a certain degree of cerebral excitation and facilitates mental work; but the abuse of this habit diminishes the mental vigour. Tobacco augments the secretion of the gastric and intestinal glands, and hence aids digestion; and it also acts as a diuretic. The action on the different organs appears to vary greatly with the dose. Thus, a small dose accelerates the heart's pulsations by direct excitation of the intracardiac ganglia; a somewhat large dose reduces the rate of the pulsations; and a lethal dose completely arrests the action by powerfully stimulating the vagi nerves.—The evil effects of excessive tobacco-smoking are elaborately treated of in a memoir by Dr A. Blatin (*Recherches Physiologiques et Cliniques sur la Nicotine et le Tabac*, Paris, 1870), which likewise includes an able investigation into the physiological action of nicotia. Dr Kopf also contributes a paper on the same subject (*De la Nicotine, Thèse de Strasbourg. Gazette de Strasbourg*, 1870; and abstract in *Bull. Génér. de Thérap.* 30 Mars, 1870, p. 284).

Pyrogallic Acid.—In a communication made to the Academy of Sciences on the 1st of March, 1869, M. J. Personne proposed that poisoning by phosphorus should be treated by the administration of oil of turpentine, on the grounds that phosphorus produces its poisonous effects by removing oxygen from the blood, and that this action is prevented by turpentine. It occurred to him that this view of the theory of phosphorus-poisoning would be greatly strengthened were similar physiological effects found to be produced by other substances, which agree with phosphorus in deoxidizing property, but present no other remarkable resemblance to it. With the object of ascertaining this, M. Personne made some experiments with Pyrogallic acid, the results of which he now briefly narrates (*Comptes Rendus*, 4 Octobre, 1869, p. 749). Two dogs received by injection into the stomach 30 and 60 grains respectively of pyrogallic acid, in a large quantity of water. Poisonous symptoms quickly supervened in both, and these symptoms closely resembled those that are caused by phosphorus. After death, the liver was found greatly enlarged, the heart soft and friable and filled with clots of black blood, and the bladder contained a brown fluid resembling that which is obtained when an alkaline solution of pyrogallic acid is shaken up with air. A microscopic examination of the heart and liver revealed an immense quantity of fat. The muscular fibres of the heart were concealed by fat globules; and the liver of the dog that had received 30 grains weighed nearly 8000 grains, or about $\frac{1}{18}$th of the whole weight of the animal. It is thus shown that two substances which agree in little else than their power of abstracting oxygen from the air cause nearly identical symptoms and morbid changes in the living economy, notwithstanding their great dissimilarity in general properties and in origin. M. Personne believes that the above results distinctly prove that both phosphorus and pyrogallic acid produce death by asphyxia, which may be either

rapid or slow, according as the quantity absorbed is such as to deprive the blood of its oxygen with greater or less rapidity.

VERATRUM VIRIDE.—It is well known that veratria, the substance frequently referred to as the active principle of *veratrum viride*, is a complex body, but it is only recently that the attempts to separate its component parts have been successful. This important work has been achieved by Mr Charles Bullock of Philadelphia, who has discovered in this substance two alkaloids associated with a resin. Professor Horatio C. Wood has carefully examined the actions of these bodies; and has named the alkaloids *Viridia* and *Veratroidia*, the former of which is soluble in ether, and the latter insoluble. (*American Journal of the Medical Sciences*, January, 1870, and Reprint.) Dr Wood's experiments have enabled him to draw up the following summary account of the action of *viridia*. 1. It appears to be but very slightly, if at all, locally irritant. 2. It has no action whatever upon the alimentary canal, never producing vomiting or purging. 3. It exerts no direct influence upon the brain. 4. It is a spinal motor depressant, producing death by paralysis of the respiratory nerve centres; and it is without action on the muscles and nerves. 5. It is a direct depressant of the circulation, lowering the force and rapidity of the blood-stream, slowing the action of the heart, and affecting the force of each single beat independently of any spinal action. The action of *veratroidia* differs considerably from that of viridia, as will be seen from the following succinct account of the effects it produces. 1. Veratroidia possesses a slight local irritant action. 2. It is an irritant emetic, and sometimes a cathartic. 3. It exerts no direct influence upon the brain. 4. It is a direct spinal motor depressant, and at the same time it acts to some extent on the nerves and muscles. 5. It depresses the heart's action both in force and frequency, but the period of depression is followed by one of reaction. It is of interest to observe that the experiments with the *resin* showed that it has no effect upon the circulation; and that it is inert as far as therapeutic properties are concerned. Indeed it seems probable that many of the disagreeable effects which commonly result from the exhibition of the ordinary veratria, are due to the presence of this resin. The important point in Dr Wood's researches is the indication of the great therapeutic value of viridia, "by means of which all the peculiar sedative influence of *veratrum viride* can be obtained, without the horrible nausea and vomiting which always occasion so much discomfort, and which in some instances endanger life." Drs Amory and Webber have published a paper entitled "A contribution to the Physiological Study of Veratrum Viride and Veratria" (*Boston Medical and Surgical Journal*, 1869, and Reprint), which, however, adds little to our previous knowledge of the subject. We have much pleasure in referring for further information to an extremely valuable monograph by Ludwig Weyland, entitled "Vergleichende Untersuchungen über Veratrin, Sabadillin, Delphinin, Emetin, Aconitin, Sanguinarin und Chlorkalium."

On the Influence of certain Poisons on the Spasm-curve of the Muscles of the Frog.—Buchheim and Eisenmenger have examined with great care the modifications in the contraction of the frog's muscles, which are produced by various poisons (*Ueber den Einfluss einiger Gifte auf die Zuckungscurve des Froschmuskels.* Giessen: Monograph). The poisons specially examined were tartar emetic, upas antjar, caffein, theobromin, cocain, chloroform, convallamarin, digitalin, quinia, napellin and lycoctonin, bile, and saponin. The method followed was to remove a muscle from the poisoned animal, affix it to a myographion, and examine the curve produced on a revolving cylinder by the muscle excited to contract by direct galvanic stimulation. From the results thus obtained, they divide these poisons into two classes. The first includes tartar emetic, bile, saponin and sanguinarin (already investigated by Weyland), which, although they exert a manifest influence upon the muscles, and by large doses or by direct application altogether paralyse them, do not produce any modification in the nature of the muscular contraction so long as this can still be excited by galvanism. The elevation of the curve, however, is somewhat lessened after large doses, but the duration of the contraction is not at all modified. In the second class, on the contrary, the duration of the muscular contraction is distinctly lengthened. With some of them, for instance napellin, quinia, digitalin, convallamarin, cocain, theobromin, caffein, and upas antjar, this duration is about double or threefold; with chloroform it is increased many times; and with veratria and allied alkaloids it may be increased by more than a hundred times the normal period of duration. The authors are unable to decide whether the change of the muscle is the same in those cases where the curve is merely doubled in duration as in those where it becomes a hundred times the normal length. Although they find that in normal muscles the length of the curve of contraction may be varied by varying the strength of the stimulus, still this fact does not aid in the solution of the problem. For in experiments with those poisons that only to an inconsiderable extent lengthen the duration of the curve, they failed in increasing the duration by augmenting the strength of the stimulus. Further, they administered different doses of upas antjar (a poison that merely doubles the duration of the curve), but neither very small doses nor very large ones made the upas curve similar to that of veratria (a poison that increases the curve more than a hundredfold). As the character of the muscular contraction in veratria-poisoning gives the impression of a tetanic spasm, and as observers have hitherto represented it as such, the authors investigated this point specially. In some experiments curara was administered after veratria had produced its peculiar muscular action; but notwithstanding that all the appearances of curara-poisoning supervened, the veratria curve was wholly unaltered. In other experiments, after veratria had been given, a ligature was tied round the leg, excluding the ischiatic nerve, and then curara was injected under the skin of the back; but it was found that the muscles poisoned with veratria and curara exhibited on

irritation exactly the same curve as those of the leg protected from the direct action of curara. It would therefore appear that in the peculiar muscular affection produced by veratria the nerve-terminations are not implicated, but that this affection is caused by a change in the muscular substance itself. The authors finally inquire, What is the nature of this change? Many poisons, such as caffein and theobromin, produce a remarkable rigidity of the muscles; and Ranke has shown that the muscles of the frog become rigid after long-continued inhalation of chloroform, this rigidity being probably caused by coagulation of the myosine. As such rigidity could never however be caused by veratria, the extraordinary lengthening of the curve of muscular contraction cannot be thus explained. At the same time, such an explanation may be reasonably applied to the majority of the other poisons that lengthen the curve of muscular contraction.

DR RUTHERFORD'S REPORT.

Physiological Chemistry[1].

Digestion.

INFLUENCE OF BILE ON GASTRIC DIGESTION. — This interesting subject has been recently investigated in an elaborate manner by Dr O. Hammarsten of Upsala (*Pflüger's Archives*, 1870, p. 53). Of course it is well known that bile retards or arrests gastric digestion, but this inquirer extends our knowledge by informing us that fresh bile taken from the ox, calf, dog, fox, cat, pig, sheep, hedgehog, rabbit, hare, various birds, among which the goose, common fowl and crow are included, and a variety of fishes, prevented the digestion of coagulated albumen when mixed with artificial gastric juice prepared from the stomach of the dog, pig, calf, fox and rabbit. Strange to say, however, bile from the hare was found unable to do this, and that of the rabbit also sometimes failed. This fact he is unable to explain.

After ascertaining the above facts, he proceeded to investigate the cause of the bile's inhibitory action in such cases, and specially endeavoured to ascertain whether it was due to an action of the bile upon the acids or on the pepsin of the gastric juice, or on the albumen which was to be digested. Brücke some time ago showed that pepsin intimately attaches itself to fine precipitates of substances with which it may have been in solution previous to their precipitation. A precipitate, consisting of Glycocholic acid, falls when bile is mixed with gastric juice; and Burkart (*lib. cit.* 1868, Heft III.) showed that much of the pepsin adheres to the precipitate, and explained the effect of the bile on digestion by pointing to this fact. In a more recent communication (*ibid.* 1869, p. 182) he maintains the validity

[1] On the present occasion Dr Gamgee is unfortunately prevented by indisposition from preparing the report on Physiological Chemistry.

of this explanation. Hammarsten, however, observes that were this explanation the only or indeed the most important one, it ought to be found that the bile of man and of several other animals, where Taurocholic almost entirely replaces Glycocholic acid, has little inhibitory action upon digestion; while that of the dog and cat, in which Glycocholic acid is entirely absent, should have no effect at all. But the bile of the dog and cat influences digestion as much as any other kind of bile. But when Glycocholic acid is absent, a precipitate nevertheless occurs on adding bile to gastric juice. This precipitate consists of the mucin of the bile or the albumen of the gastric juice, if the artificial juice contain any. Some of the pepsin probably attaches itself to these precipitates. Hammarsten, however, found that digestion was prevented *although precipitation was altogether prevented* by taking bile which contained no precipitable acid, and removing its mucin, and likewise by removing the albumen from the gastric juice. He therefore concluded that precipitation of pepsin is not the only and probably not the most important cause of this effect of bile. He found that bile exerts a slightly deleterious influence upon the digestive power of pepsin, but this he found insufficient to account for the remarkable influence of bile in question. The major explanation of this he thinks is to be found in the absorption of bile by the coagulated albumen used in the experiments. In consequence of this the albumen was so altered that it remained undigested even when placed in fresh gastric juice. When, however, the bile was extracted from the albumen, the latter usually readily yielded to the influence of the juice. Hammarsten therefore concluded that bile prevents digestion chiefly because it renders albumen indigestible.

The next question considered by him was, What constituent of the bile is the inhibitory agent? Brücke had previously ascertained that a solution of the bile-acids can prevent digestion; but he made no observations upon the other biliary constituents. Hammarsten was deterred from making direct observations regarding the influence of the cholesterine and pigment because of his inability to find any solvent for these which did not itself interfere with digestion. He concludes that these however are probably of no importance, seeing that a solution of bile-acids retards digestion as thoroughly as bile itself does. He further found that the inhibitory influence of Glycocholic is exceedingly slight when compared with that of Taurocholic acid. His conclusion therefore is that the bile prevents gastric digestion not merely by precipitating pepsin as Burkart maintains, but also by rendering the albuminates indigestible; and that Taurocholic acid is the primary and Glycocholic acid the secondary biliary constituent which effects this.

Wittich, "On a New Method for Obtaining a Fluid for Artificial Digestion" (*Pflüger's Archives*, 1869, p. 193).

Blood.

Grünhagen, "A Remarkable Influence of Glycerine upon the Substances which give rise to Blood Fibrin" (*Henle und Pfeufer's*

Zeitschrift, 1869, p. 239). When Glycerine is added in sufficient quantity to a mixture of Fibrinogen and Fibrino-plastic substance, it prevents their forming Fibrin, but preserves them unchanged for an indefinite period. If, however, the mixture be sufficiently diluted with water, the formation of Fibrin takes place.

Richardson, "On the Cause and Prevention of separation of Fibrine in the body" (*Med. Times and Gazette*, 1869). A very interesting lecture.

Geinitz, "Influence of Hydrocyanic Acid upon the Red Blood-Corpuscles" (*Pflüger's Archives*, 1870, p. 46).

Zahn, "Researches on Serum-Albumen" (*Ibid.* p. 74).

Creite, "On the Action of Serum-Albumen after its Injection into the Blood" (*Henle und Pfeufer's Zeitsch.* (3) XXXVI. p. 90. *Centralblatt*, 1869, p. 780).

Milk.

Kemmerich, "Contributions to the Physiological Chemistry of Milk" (*Ibid.* II. p. 401. *Centralblatt*, 1870, p. 8. See Power's Report, *Brit. and For. Med. Chi. Review*, January, 1870).

Bile.

Bogoljubow, "Amount of CO_2 in Bile" (*Centralblatt*, 1869, p. 657).

Urine.

Stadion, "Estimation of Uric Acid in Human Urine" (*Zeitsch. für Biologie*, V. p. 66. *Centralblatt*, 1869, p. 846).

Le Gros and Onimus, "On the Elimination of Urea under the Influence of Electrical Currents" (*Revue Médicale*, II. 432. Power's Report, *Brit. and For. Med. Chi. Review*, January, 1870).

Senff, "On Diabetes after Inhalation of Carbonic Oxide" (*Inaugural Thesis*, Dorpat, 1869. Abstract in *Centralblatt*, 1869, p. 727).

Nerve.

Funke, "On the Formation of Acid in Nerves" (*Centralblatt*, 1869, p. 721).

Muscle.

Perls, "On the Amount of Creatine in Human Muscles during various Diseases" (*Deutsches Archiv für Klinisch. Med.* 1869, VI. p. 243. *Centralblatt*, 1869, p. 836).

O. Nasse, "Contributions to the Physiology of Contractile Tissue" (*Pflüger's Archives*, II. p. 97. Abstract in *Centralblatt*, 1869, p. 567).

Miscellanea.

C. Voit, "Remarks on the so-called Luxus-Consumption" (*Zeitsch. für Biologie*, 1869, IV. p. 517). "On the Formation of Fat in the Animal Body" (*Ibid.* V. p. 79). "On the Retrograde Metamorphosis of Albumen during an Albuminous and Fatty diet, and On the Part which Fat plays in Nutrition" (*Ibid.* V. p. 329).—Pettenkofer and Voit, "Experiments on the Respiration of Dogs during Fasting and during an exclusively Fatty Diet."

The second of these memoirs contains a very complete history of the question regarding the formation of fat in the animal body. Beccaria (1742), Prout and Dumas (1841) asserted that the fatty materials of the body are all merely absorbed from the food. Liebig was the first to dispute this doctrine, and maintained that a considerable portion of an animal's fat may be derived from hydrocarbons. This idea he supported by quoting numerous facts in Chemistry and Botany, and also the fact that bees form wax from sugar. Afterwards Liebig, together with Playfair, Dumas, and Milne-Edwards, Thomson, Lawes and Gilbert, showed that there is much more fat in the milk of animals than is contained in their food.

Liebig was the first to suggest the possibility of the derivation of fat from albumen. The appearance of fats and fatty acids during the decomposition of albuminates and during the ripening of cheese (Fourcroy, Berzelius and others), the formation of adipocire (Fourcroy, Gibbes, Quain, Gregory and others), the fatty metamorphosis taking place in albuminous tissues introduced into the peritoneal cavity (Hunter, Berthold, R. Wagner and others), fatty degeneration of albuminous tissues, formation of fat in milk after its removal from the body (Hoppe-Seyler, Kemmerich), and lastly, its production during the development of eggs (Burdach), have been referred to as evidence of the derivation of fat from albumen. Pettenkofer and Voit (1862) were however the first to show that there is really good ground for believing that albumen is one of the sources of fat *in* the body; they pointed out that in the carnivora fat must be derived from albumen, and further Ssubotin furnished the most valuable proof when he showed that the amount of fat contained in milk increases with the albuminates in the food (see my Report in this *Journal*, 1866, p. 159). Voit has made observations similar to Ssubotin's, from which he concludes that in the herbivora, the fat and albumen of the food are sufficient to account for all the fat contained in the milk, and that the milk fat is not derived from hydrocarbons. Hermann (*Centralblatt*, 1869, p. 875) however objects that Voit has not furnished the necessary proof for the reasonableness of the latter statement.

In his third memoir Voit gives the following result of experiments on the retrograde metamorphosis of albumen on a diet containing both albumen and fat. This research is the sequel to that on the retrograde metamorphosis of albumen during a purely albuminous diet (*Centralblatt*, 1867, p. 486). He finds that the addition of fat to a flesh diet diminishes the metamorphosis of albuminates. (In his experiments he took the amount of Urea excreted as the indication of the retrograde metamorphosis of albuminates.)

In the research on the respiration of dogs Pettenkofer and Voit found that during fasting the amount of oxygen absorbed by the lungs exactly suffices to oxidize the quantities of fat and albumen which—according to their calculations—undergo destruction. On an exclusively fatty diet the amount of oxygen really absorbed was below that which they calculated. This they explain by supposing that fat had in the intestine been decomposed into various gases.

The amount of oxygen absorbed is much diminished by an exclusively fatty diet, ~~and the retrograde~~ metamorphosis of fat in the body ~~not~~ only not increased, but actually diminished. The authors think that it is erroneous to suppose that fat robs albumen of some of its oxygen, and thereby diminishes the metamorphosis of albumen, and believe that the diminished metamorphosis of albumen is really due to the diminished absorption of oxygen occasioned by the fat.

Perls, "On a New Method for estimating the amount of Urea in Blood and in the Tissues" (*Centralblatt*, 1870, p. 49).

A. Schmidt, "Researches on Sepsin" (*Inaugural Dissertation*, Dorpat, 1869. *Centralblatt*, 1869, p. 554).

"On Food," by H. Letheby, M.B., Professor of Chemistry at the London Hospital Medical College. London, Longmans, 1870.

Nervous System.

BRAIN.—Hermann and Escher (*Pflüger's Archives*, 1870, p. 3) detail experiments undertaken with a view to ascertain the cause of the convulsions which follow disturbance of the circulation within the cranium. They found that arrest of the flow of blood *to* as well as *from* the brain gives rise to similar convulsions. They agree with Rosenthal that the cause of these consists in the arrest of gaseous exchange between the nerve tissue and the blood, but they are unable to say whether the absence of oxygen or the increased amount of carbonic acid is the cause of the excited action.—Dr F. J. Brown, "On the mode in which Direction is ascertained by Migratory Animals," *British Medical Journal*, 5th Feb. 1870.—Prevost, "Experimental Research Regarding the Rotatory Movements Resulting from Unilateral Lesions of the Brain." (*Gazette Médicale*, 1869. No. 9.)

SPINAL CORD.—Fick (*Pflüger's Archives*, 1869, p. 414) and Budge (*Ibid.* p. 511) detail experiments to show that contractions follow stimulation of the anterior columns of the spinal cord, a statement which has been denied by Mayer and others. (See *Jl. of Anatomy and Physiology*, 1869, p. 462.)—Brown-Séquard (*Lancet*, 1st January, 1870) mentions experiments which seem to him to show that the motor nerve fibres which throw muscles into contraction during fits of epilepsy are quite distinct from *voluntary* motor nerve fibres. The two sets of motor nerve fibres do not occupy the same situation in the spinal cord, the voluntary motor fibres being chiefly in the anterior column, and the anterior part of the grey matter, the others being chiefly in the lateral column.—Masius and Lair, "On the Position and Extent of the Reflex Centres in the Spinal Cord of the Frog" (*Centralblatt*, 1870, No. 1).—Uspensky, "Influence of the Continuous Current upon the Spinal Cord" (*Ibid.* 1869, p. 577).

NERVES.—Dr William Ogle contributes a most interesting and instructive paper on "A Case Illustrating the Physiology and Pathology of the Cervical Portion of the Sympathetic Nerve." (*Med.-Chi. Trans.* London, LII.)—Svierczewski (*Centralblatt*, 1869, p. 641) de-

scribes movements within the nuclei of sympathetic nerve cells and the effects of various reagents upon these, &c.—Lewisson, "Inhibition of Motor Nerve Centres Resulting from the Stimulation of Sensory Nerves" (*Reichert und Du Bois Reymond's Archives*, 1869, p. 255). —Fick, "On Electrotonus" (*Fick's Untersuchungen*, I. 129).—Ewald, "On the Independence of Nerve Excitability upon Oxygen" (*Pflüger's Archives*, 1869, p. 142).—Dr Lockhart Clarke, "On the Physiology of Ear Cough" (*Brit. Med. Journal*, 15th January, 1870).

Vascular System.

Belina-Swiontkowski, *On the Tranfusion of Blood in its Physiological and Medical Relations*, 8vo. pp. 156, Heidelberg, 1869. (See *Centralblatt*, 1869, p. 391.)—Mittler, "Researches on the Transfusion of Blood" (*Wien. Acad. Berichte Math.-Natur*, Cl. 2, Abtheil. LVIII. Nov. Heft, 1868. See *Centralblatt*, 1869, p. 391).—Berthold, "Circulation of Blood in Closed Cavities," *Centralblatt*, 1869, p. 673. —Landois, "On two Distinct Causes of Catacrotous Waves in Pulse Curves" (*Centralblatt*, 1869, p. 753), considers that hitherto no author has given a correct explanation of the cause of the wavelets which are found in the descending limb of a pulse tracing. He thinks they are due to oscillations produced by recoil of the vascular walls and recoil from the aortic valves. He agrees with Buisson and others in ascribing the larger of the catacrotous waves to recoil from the aortic valves. He does not seem to have read Dr Sanderson's work on the Sphygmograph.—Fick, "On the Rapidity of the Blood Current in the Human Arteries" (*Fick's Untersuchungen*, 1869, p. 51. *Centralblatt*, 1870, p. 55), describes an ingenious apparatus and method by which the rapidity of the blood-current may be ascertained.

Dr Joseph Coats of Glasgow has, under the direction of Ludwig, investigated the change which takes place in the work done by the heart during irritation of the vagus. The experiments were performed on the hearts of frogs, which had been removed from the body and which were kept filled, and at the same time nourished with blood serum from a rabbit. The interior of the ventricles was placed in connection with a kymograph, by means of which the force, extent and rapidity of the heart's contraction was ascertained. He found that irritation of the vagus always diminished the work done by the heart; not only within a given period, but at each contraction. He found that when the vagus is slightly irritated, it sometimes happens that the force of the cardiac contractions is diminished while their frequency is not lessened. These changes in the working of the heart took place although the pressure of the blood within the heart remained unaltered, and the nutrition of its fibres uninterfered with; conditions whose variation may have had an important influence on the results of experiments performed on higher animals whose hearts were not removed from their bodies. Moreover the disturbing influence of the bloodvessels upon the blood pressure, which is so troublesome in experiments performed on living animals, was absent in Dr Coats' experiments. His novel mode of experi-

mentation renders the results obtained by him extremely interesting. (*Berichte der König. Sächs. Gesell. der Wissenschaften*, 12th December, 1869).—Czermak (*Wiener Akad. Berichte*, II. Abtheil. Febr. Heft, 1869) describes among other instruments an ingenious Cardioscope, suitable for demonstrating the movements of the heart of an animal, such as a frog, to distant spectators.

On the movements of the heart consult Dr Michael Foster's admirable lectures on Involuntary Movements, delivered at the Royal Institution during 1869. (Fullerian Lectures, published in extenso in the *Revue des Cours Scientifiques*, 1869. Nos. 42, 43 and 45.)

INFLUENCE OF COLD DRINKS ON BLOOD PRESSURE.—Hermann and Ganz (*Pflüger's Archives*, 1870, p. 8) have endeavoured to ascertain what may be the reason for the widely-spread belief that cold drinks are dangerous during a heated state of the body. They injected water at a temperature of 0°C. into the stomachs of dogs. The blood pressure always rose after an injection. This result cannot in their opinion be ascribed to absorption, because it appeared very speedily after the injection, and moreover hot water failed to produce it. The tracing obtained by the kymograph further showed that the increased pressure was not due to increased cardiac action; they therefore ascribed it to contraction of the vessels due to the cold. They suppose that the evils which are commonly ascribed to drinking cold water during a heated state of the body are due to the sudden increase of blood pressure which the cold produces, favouring congestion of the brain and lungs. Quite in opposition to what one would have anticipated, they found the increase of pressure much less in animals previously paralysed by Curara. They fancy that when an animal is not so paralysed, the cold by increasing the frequency of the respirations and the depth of the inspirations brings into play a compensating mechanism which keeps the pressure from rising so much as it otherwise would (?). It is satisfactory to know that they intend to investigate the whole question further.

Respiration.

Leçons sur la Physiologie Comparée de la Respiration, by Paul Bert, Professor of Physiology, Paris. Baillière, 1870. 8vo. pp. 588. We are compelled to postpone our analysis of this very valuable work by the distinguished successor to Claud Bernard.

Digestive System.

PANCREAS.—N. O. Bernstein (*Sächs. Acad. Berichte Math. phys.* Cl. 1869, p. 96. *Centralblatt*, 1869, p. 710) has under the direction of Ludwig made important observations on the pancreatic secretion. The secretion was obtained from permanent fistulæ. Bernard had previously pointed out that digestion caused an increase in the secretion; Bernstein found that *during fasting* the secretion *is arrested*. During the first hour after taking food it becomes tolerably abundant. It attains its maximum during the second or third hour. It then

declines, but rises again during the fifth, sixth, and seventh hours, and then slowly sinks to zero. The commencement of the secretion is apparently the reflex result of the introduction of food into the stomach, and the increase which takes place at the fifth hour seems to result from the entrance of the chyme into the intestine. In addition however to these major variations there are a number of irregular smaller ones. His observations corroborate those of Bernard and Weinman with regard to the influence of vomiting: this arrests the secretion. He believes that the arrest is due to a reflex influence transmitted from the stomach through the vagi; because when the vagus is divided in the neck, stimulation of its cranial end arrests the secretion (stimulation of the lower end has no effect). He found that division of the nerves which accompany the arteries to the pancreas was followed by an abundant normal secretion, which no longer intermitted, as it did before division of the nerves. In these cases the gland was reddened and sometimes œdematous. After division of these nerves stimulation of the vagus failed to arrest the secretion. The influence of nerves upon the amount of blood contained in the gland could not be definitely ascertained. In opposition to Bernard he found that the secretion collected from *permanent* fistulæ did not degenerate but retained all the properties of the secretion first obtained. The solids of the secretion were found to vary between 1·68 and 5·39 per cent. In general the amount of solid matter was inversely as the rate of secretion. The variation in the amount was almost entirely due to the varying quantity of organic matter, for the inorganic solids varied only from 0·7—1 per cent.

Ear.

According to Bert (*Comptes Rendus de la Société de Biologie*, 1869), rotatory movements analogous to, but less energetic than, those which follow section of the semicircular canals, may be produced by gently injecting ice-cold water into the ear of a rabbit. The animal falls over on the side on which the injection is made. The usual modifications in the movements of the eye and iris of the same side are present in such cases.—Samuelsohn "On Subjective Sounds" (*Virchow's Archives*, XLVI. p. 509).—Moon, "On the Structure of the Human Ear, and on the Mode in which it Administers to the Perception of Sound" (*Phil. Magazine*, Aug. 1869).—Jago, "The Functions of the Tympanum," *Brit. and For. Med. Review*, 1870, p. 229.

Eye.

INNERVATION.—Adamük (*Centralblatt*, 1870, p. 65) communicates the results of experiments undertaken under the direction of Donders with a view to determine whether or not one eye can move independently of the other. The chief result of the research is that both eyes have a common motor innervation which proceeds from the anterior corpora quadrigemina. The right nates governs the movement of both eyes towards the left, and the left both eyes towards the right. Irritation of various parts of the corpora calls forth

various movements, but always in both eyes at the same time and in the same direction. If the irritation be long continued the head turns to the same side as the eyes. If the corpora of one side be separated from those upon the other by an incision in the mesial plane, and the corpora of either side then stimulated, movement takes place in the eye of the same side only. When as sometimes happened the eyes were somewhat divergent in a state of rest, irritation of the anterior part of the nates close behind the posterior white commissure caused the eyes to turn so that their antero-posterior axes became parallel. If a point between the nates somewhat further back be stimulated, both eyes turn upwards and the pupils contract. The movement of the eyes becomes more and more convergent the further back the seat of the irritation. When the hinder and under part of the nates is stimulated, the eyes straighten, converge, and incline downwards, and the pupils contract. Stimulation of the testes produced wide dilatation of the pupil with powerful general movements of the narcotised animals. Adamük never found any other influence produced by the testes upon the ocular movements than the preceding, although Schiff has said that the movements are specially under the governance of the testes. Adamük is convinced by these facts that the eyes constitute as regards their movements an indivisible whole.—Dr Argyll Robertson ("On Spinal Myosis," *Edin. Med. Journ.*, Dec. 1869), in describing four cases of Spinal Myosis which he had under his care, points out the interesting fact, that although the retina was quite sensitive and the pupil contracted during accommodation of the eye for near objects, yet an alteration in the amount of light admitted to the eye did not influence the size of the pupil. The fact that a strong light failed to call forth further contraction of the pupil was not apparently due to the fact that the pupil was much contracted; because it contracted further during positive accommodation, and moreover Calabar bean rendered it still smaller. Dr Robertson remarks that "the only possible solution of the difficulty is to be found in the theory, that for contraction of the pupil under light it is necessary that the cilio-spinal nerves remain intact." These nerves were paralysed in the cases described by him. Hitherto the contraction of the pupil caused by light has been invariably referred to reflex stimulation of the ciliary branches of the third pair which supply the circular fibres of the iris. Robertson says that if this view were correct he sees no reason why in these cases light did not influence the pupil. In all the retina was thoroughly sensitive to light, and in all of them the ciliary branches of the third pair were healthy and active. But in all the cases there were symptoms of spinal disease, and in all—myosis—due to palsied cilio-spinal nerves. He is therefore inclined to believe that contraction of the pupil produced by light is not a reflex motor act but "an isolated example of normal temporary reflex paralysis[1]."—F. Arlt (junior), *Archiv für Ophthalmologie*, xv. 1,

[1] I would suggest to my learned friend that should his ingenious view prove to be correct, this phenomenon will not be "an isolated example of normal

p. 294, finds that on irritating the cervical sympathetic in rabbits, the pupil reaches its maximum dilatation ere there is any evident change in the vessels of the eye, another argument against the notion that the pupil change is due to vascular change. Other experiments performed by him confirm an observation made by Donders to this effect, that when a strong light is allowed to fall on one eye the pupil of that eye does not contract sooner than that of the other eye not exposed to the light.

See a "Report on the Physiology of the Iris" in the *Lancet*, 22nd January, 1870.

According to Bert (*Archives de Physiologie*, 1869, p. 548), all animals see all the rays of the spectrum that are seen by us, and cannot see those which are invisible to us. The differences in the illuminating power between the various coloured rays in the visible region of the spectrum appear the same to the lower animals as they do to us. He infers from this that there are such relations between the kinetic energy of the vibrations giving rise to light on the one hand, and the constitution of the nervous apparatus—whether it be the peripheral or central terminations of the optic nerves—on the other, that each sort of vibration always produces the same impression upon the nerve mechanism.

Vierordt, "Description of a Method for Measuring and Comparing the strength of Coloured Lights" (*Poggendorff's Annalen*, cxxxv. p. 200. Abstract in *Centralblatt*, 1869, p. 615).

Hermann, "On the appearance of Simultaneous Contrasts" (*Pflüger's Archives*, 1870, p. 13).

Exner, "On the Time Necessary for Visual Perception" (*Wien. Acad. Berichte Math.* Cl. 2, Abtheil. LVIII., October. Abstract in *Centralblatt*, 1869, p. 538).

Woinow, "New Apparatus for Ophthalmometry" (*Centralblatt*, 1869, p. 497).

Animal Heat.

Richardson, "On Increment of Animal Heat" (*Med. Times and Gazette*, 1869). A lecture which will repay careful perusal.

Animal Electricity.

The strange vicissitudes which have chequered the history of Animal Electricity are far from being ended. The joy with which poor Galvani would have hailed the invention of the Galvanometer, and the blow which its revelations seemed to give to the theories of his irrepressible adversary Volta, must now have been turned into mourning by the ruthless fashion in which Hermann makes deadly thrusts at theories which have been fondly confided in for quite a respectable period of time. After all that Du Bois Reymond and others have said regarding the muscular and nervous currents we are

reflex paralysis," but another example of direct inhibitory action of centripetal nerves upon a motor nerve-centre. (W. R.)

now informed that these cannot be shown to exist in *uninjured* muscle or nerve during a state of rest. Hermann (*Untersuchungen zur Physiologie der Muskeln und Nerven*, 3te Heft, pp. 98, Berlin. Abstract in *Virchow und Hirsch's Jahresbericht*, 1869, Anatomie und Physiologie Abtheil., p. 106) describes with reference to this subject researches on frogs, from which the skin had not been removed. When he placed two parts of the cutaneous surface, one on the foot, the other on the back, in contact with the clay electrodes of the galvanometer he obtained a current, which however depended on the heterogeneity of the portions of skin; for when one of the portions of skin was corroded with creosote or nitrate of silver, it was always found to be + when compared with a normal portion of skin. When both portions were so treated and their heterogeneity completely destroyed, no electrical current was obtained if the corroded parts were *immediately* placed in contact with the electrodes. Often however after half an hour or more an extremely weak ascending current became evident in the limbs on which the experiments were made. This current however is not regarded by Hermann as a muscular current proper, but as the result of a corrosion of the muscles of the foot by the passage of the corroding agent through the skin; for in these cases the muscles of the foot were on removal of the skin found to be corroded, but the muscles of the back under the other corroded portion of skin were not acted upon by the corroding agent. He satisfied himself that this was the true explanation of the appearance of the current by the following experiments. When he kept frogs treated in the above manner until the following day, the current between the two corroded portions of skin remained unchanged: when however the skin of the other foot was corroded and compared with the old corroded skin on the back, there was at first no current between them, but afterwards a feeble current slowly made its appearance. Moreover this weak ascending current was never observed if the skin of the foot were corroded over the tip of the longest toe, where there are no muscles under the skin. Hermann then describes experiments in which he found that laying bare the muscles causes a current to appear in them. He thinks that the origin of the current in this case may be explained by the theory that the removal of the skin speedily leads to death of the muscular substance, just as destruction of the continuity between the blood and the living membrane of the blood-vessels leads to death of the blood (Brücke). Death first takes place at the surface of the muscle. The superficial fibres die throughout their whole length. When a transverse section is made, a portion of each fibre rapidly dies: the living portion of the fibre becomes +, the dead part −; hence the muscular current. The muscles of animals during hybernation are "indolent," and therefore slightly sensitive to the effect of exposure: these in consequence shew no current. If the muscle shew no current during rest, one appears when it is thrown into action by indirect stimulation (that is, through the nerve). Hermann thinks this may be explained by supposing that the wave of irritation moves from the entrance of the nerve towards the ends

of the muscle unequally, so that the different parts of the muscle are thrown into different electrical states. Hermann finds that the weak currents obtainable from glands, such as the liver and spleen, etc., entirely disappear when the blood is removed from them. He ascribes the current to opposite electrical relations of blood, which is *dead* at the cut surface and *living* within the vessels of the gland. In the case of uninjured nerve (optic), Hermann failed as certainly as Du Bois Reymond to obtain evidence of any current. Hermann's conclusion from these and other data (for which vide the original Memoir) is that muscle and nerve currents do not exist in nerves or in muscles in a state of rest, but that when found they are a sign of partial death or unequal action of different parts of tissue (in the case of muscle at any rate); in fact that their cause is to be found in heterogeneity in the chemical states of different parts of the tissue, however induced. Munk (*Reichert's Archives*, 1868, p. 529) has entered the lists against Hermann. He maintains that a weak current can be shown to exist in the frog's limb while its muscles are uninjured and at rest. Hermann replies however (*Pflüger's Archives*, 1870, p. 15), that the current obtained by Munk is so weak as really to be unimportant. He repeated his experiments with a more delicate galvanometer than he had previously used, and found that he was able to obtain from the gastrocnemius muscle of a frog a deviation of the galvanometer needle indicated by 10—20 divisions of the scale on which the pencil of light was reflected from the mirror of the galvanometer (an ordinary *nerve* current gave a deviation of 300 divisions). The gastrocnemius used in this experiment was very carefully prepared. It was kept from contact with the cutaneous secretion; it was not cut or lacerated in any way. The one electrode was placed in contact with the divided Tendo Achillis, while the longitudinal surface of the muscle was brought into contact with the other. The current obtained was indeed a trivial one. Hermann thinks it will be found to be entirely absent when a more careful method of experimenting has been hit upon. This question is therefore as yet unsettled, and doubtless it will long remain so, but it seems certain that Hermann has given a severe blow to the notion that the electrical state of muscles and nerves, etc., is as has hitherto been generally believed. See also Hermann "On the Course of the Development of Currents during the Death of Muscles" (*Ibid.* p. 39).

Miscellanea.

INFLUENCE OF DIFFERENT LUMINOUS RAYS UPON THE ETIOLATION OF ANIMALS.—Most animals, as is well known, become blanched when kept in darkness. Bert (*Comptes Rendus de la Société de Biologie*, 1869) has endeavoured to ascertain what are the luminous rays which are concerned in pigmentation. He reared a number of Axolotls in vases, some of which he covered with orange-coloured glass, others with white glass. Some were freely exposed to the light, whilst others were placed in darkness. Those under the orange glass were as devoid of pigment as those kept in the dark, while those under the influence of white light were strongly pigmented. Inasmuch as

the orange glass permits of the passage of all the luminous rays of the spectrum with the exception of the blue and violet, Bert concluded that it is the blue and violet end of the spectrum which presides over the formation of pigment.

ABSORPTION BY BLADDER.—Bert and Jolyet (*lib. cit.*) have, in opposition to Susini (*Humphry and Turner's Jl.* 1868, III. p. 220), found that such substances as iodide of potassium, strychnia, etc., are perfectly absorbed by the walls of the rabbit's bladder.

INFLUENCE OF ALTITUDE ON ANIMAL TEMPERATURE, ETC.—Lortet (*Comptes Rendus*, LXIX. p. 707), during two ascents which he made of Mont Blanc, experienced the usual acceleration of respiration and circulation which has so often been noticed in a cool and rarefied atmosphere. The radial artery appeared to be almost empty. A sphygmogram showed very marked dicrotism of the pulse. His observations on temperature are most interesting. During the ascent, the temperature (that of the mouth was always taken) fell to the extent of 4—6°C. *On taking rest it rose to its normal height, but always fell during muscular exertion.* This diminution was not observed when digestion was going on. (*Centralblatt*, 1869, p. 782.)

See able lectures by Dr Richardson "On the Action of Induced Electricity upon Animals" (*Med. Times and Gazette*, 1869), and important articles (anonymous) "On the Origin of Life" (*Brit. Med. Jl.*, 1869).

NOTICES OF RECENT DUTCH AND SCANDINAVIAN CONTRIBUTIONS TO ANATOMICAL AND PHYSIOLOGICAL SCIENCE. By W. D. Moore, M.D., Dub. et Cantab., M.R.I.A., &c. &c.

1. Several reprints of papers by J. G. H. Kinberg, published in the *Summary of the Transactions of the Royal [Swedish] Academy of Science*, 1867—69, (*Ofversigt af Kongl. Vetenskaps-Akademiens Förhandlingar*). Some of these contain accurate anatomical measurements and other matters likely to interest the readers of this Journal; a detailed examination would, however, be out of the question, I can, therefore, do little more than enumerate the titles of the papers. They are,

(1) On Arctic Phocaceæ, found in the midst of the glacial regions of Sweden. Eleven specimens. Measurements of the several bones in millimètres.

(2) On some bones and implements found at Hästefjord. Man and various animals.

(3) On a skeleton of a fox found at a depth of 10—15 feet at Marieberg near Uddevalla.

(4) On the classification of the Family Amphinome.

(5) On the origin of the second cervical vertebra from the fusion of two vertebræ.

The author sums up this paper in the following words: "What has here been briefly stated ought to be sufficient to shew, that at least in mammalia in general the odontoid process is, during a longer or shorter period, separated in the same manner as other adjoining vertebræ, by two intervertebral epiphyses, from the proper corpus epistrophei[1]; that the odontoid process has parts corresponding to the arch, though not developed into an actual bow, but formed analogously to certain vertebræ in the swan; that thus the axis has two bodies, which coalesce analogously to the fusion of the sacral vertebræ, and that so finally the axis arises from the fusion of two vertebræ."

(6) On regeneration of the head and the anterior segments in an Annulatum.

(7, 8, 9, 10) On Annulata nova.

2. (1) The second part of the first volume of the new Scandinavian Journal, the Northern Archives of Medicine (*Nordiskt Medicinskt Arkiv*), intended to be the exponent of the progress of Medical Science in Sweden, Norway, Denmark and Finland, contains a paper by Hjalmar Heiberg, Assistant in the pathologico-anatomical

[1] The Swedes apply the term "epistropheus" to the second vertebra, and not, as some writers do, to the first.

Laboratory in Christiania, on the periphery of the Tunica Descemeti and its influence on accommodation. Professor Donders, in his classical work, published by the New Sydenham Society, attributes to the ciliary muscle the important quality of accommodation muscle, but adds that opinions are much divided as to its *modus operandi* in altering the form of the lens. At the present day, according to Hr. Heiberg, most observers are agreed that both the circular and the radiating and longitudinal muscular fibres coöperate in making the lens more convex, and that this takes place through the relaxation of the Zonula Zinnii. After some minute anatomical details, in which to follow the author would lead me beyond my limits, Hr. Heiberg adds:

"I assume in fact, that the meshes running a circular course in the deeper layer of the ligamentum pectinatum become, during the contraction of the ciliary muscle, elongated in their shortest diameter, and so come to assume more and more the same form as those lying more superficially, and even have their longest diameter perpendicular to the direction of the canal of Schlemm, a change of form which is considerably facilitated by contraction of the muscular fasciculi running a circular course in the ligament. The change the meshes undergo may be most nearly compared to a somewhat analogous child's toy, which can be elongated and shortened."

If Pelechin's view be correct, that the canal of Schlemm is neither a venous sinus nor a lymphatic, it is to be looked upon, according to Hr. Heiberg, as a kind of modified bursa, which will of course considerably facilitate the play of the ciliary muscle, or rather of its tendon.

"It is remarkable," adds the author, "and would seem to corroborate the hypothesis here enunciated, that the ligamentum pectinatum has a very unusual development in the seal, an animal to which we may attribute, as a consequence of its amphibious nature, a very great accommodative capacity. The network in the periphery of the Tunica Descemeti here in fact forms a part about 3‴ in thickness and 5 or 6‴ in length, which will therefore, of course, oppose much less resistance to the excursions of the ciliary muscle and of the muscular structure of the Iris."

As a practical deduction from his paper, the author suggests the possibility of remedying astigmatism by operative interference. The object of the steps which he proposes is partially to throw back the anterior insertion of the ciliary muscle. The details of the suggested operation would be out of place in this Journal. The paper is illustrated with a beautifully executed plate.

(2) E. Nordensson, Medical Student in Stockholm, describes an abnormal origin and course of the superior laryngeal nerve, a variety mentioned neither in the larger anatomical manuals, nor in *Die Nerven-Varieteten beim Menschen von W. Krause und J. Telgman, Leipzig*, 1868.

"The superior laryngeal nerve arises from the vagus behind the styloid process, runs downwards and forwards to the space between the os hyoides and the thyroid cartilage, where it perforates the

thyroid membrane, to ramify in the larynx. Four lines below its origin from the vagus it anastomoses with the latter, and before entering the larynx it gives off a small descending branch, which gives ramifications to the thyrohyoid muscle, the sternothyroid and the inferior constrictor pharyngeus, which it perforates, and between this muscle and the thyroid cartilage it is prolonged downwards to the cricothyroid muscle, in which it disappears, in its course giving off branches anastomosing with the external superior laryngeal nerve. After entering the larynx it gives off a number of branches to the mucous membrane at the base of the tongue, the epiglottis, plica aryepiglottica, also a branch to the arytenoid muscle, and a long descending branch, which on the posterior surface of the posterior crico-arytenoid muscle anastomoses with a branch from the recurrent nerve.

"The external superior laryngeal nerve arises from the superior cervical ganglion, descends behind the carotid vessels to the inferior constrictor of the pharynx at its attachment to the thyroid cartilage, resolving itself into several branches, of which one passes upwards and backwards between the inferior constrictor and the palato-pharyngeal muscles in which it is lost. While some of the other branches are in part lost in the cricothyroid muscle, in part perforate the latter, to anastomose on its posterior surface with the recurrent nerve, others are directed upwards to the laryngeal protuberance, where they end in the middle lobule of the thyroid gland.

"The cricothyroid muscle is supplied with nerves from the external superior laryngeal nerve and a branch of the superior laryngeal nerve; the arytenoid muscle obtains its nerves from the internal superior laryngeal nerve, and all the other internal muscles of the larynx are supplied with nerves from the recurrent.

"It may be of interest to mention, that in the same part the ramus descendens novi arises from the vagus, where it passes the atlas and descends on the front of the sheath of the carotid vessels. As it sweeps by the hypoglossal nerve at the curvature of the latter horizontally forwards, it receives some filaments from it."

(3) To the third number of the same Journal Dr George Asp of Helsingfors contributes an elaborate paper on the minute structure of the Liver in the Mammalia. The leading inferences deduced by the author from his observations are contained in the following propositions.

1. "No conditions respecting situation and direction are in the lobules, and probably in the liver at large, arranged according to the 'law of chance,' but, on the contrary, according to strictly geometrical laws, in general related to the number three or six. 2. The hepatic cells have a definite form, which appears regularly in every representation of a carefully made preparation, no matter in what direction the section may fall. 3. The normal hepatic cell has two opposite, six-sided surfaces and twelve four-sided, it has thirty edges and eighteen angles; in making a diagram of an hepatic cell it may be represented under the form of an hexagonal double pyramid with truncated apices or poles. 4. The cells are arranged longitudinally

in rows between the blood-vessels and transversely in layers, so that the truncated poles lie in the same plane. 5. Each hepatic cell abuts with three edges upon three blood-vessels, and likewise with three edges upon the corresponding edges of the adjoining cells, and with two surfaces upon the cells in the same row; it may thus be said with respect to the situation of the cells to each other, that they form a network. 6. Each cell abuts moreover with all its quadrilateral surfaces upon the lymphatic spaces. 7. The bile-ducts form a regular network running over the surfaces of the cells, nowhere along the edges. 8. On two of these surfaces, namely the two hexagonal truncated poles, these ducts divide into three and anastomose at definite points with the ducts from the adjoining cells. 9. The bile-ducts must have proper walls, principally for the reason that they in every place where they run over the quadrilateral surfaces of the cells, pass the lymphatic spaces. 10. The blood-vessels exhibit the figure of a radiating partition-work, which likewise divides into three without transverse anastomoses. 11. The lymphatic spaces surround with hexagonal rings both the blood-vessels and every cell, which rings by touching one another form a coherent network, whose meshes run in a direction opposite to that of the bile-ducts. 12. The lymphatic spaces, which are in themselves, so to speak, amorphous, because they occupy only the space the other tissues leave them, have not any proper boundary membrane. 13. All these parts, except bile-ducts and blood-vessels, stand in direct contact with each other. 14. We may make sections of an hepatic lobe in two principal directions: vertically to and parallel with the radii; and we thus obtain different figures." These different figures are described, and are also illustrated in the very beautiful coloured plate and in the diagrams which accompany Dr Asp's paper.

3. The concluding part of the fourth volume of the Transactions of the Medical Society of Upsala (*Upsala Läkareförenings Förhandingar*) contains a review, extending to 34 pages, by Frithiof Holmgren, of the recent history of the physiology of muscle; also a further notice, by the same author, on the subject of flesh-eating doves.

4. In the "Reports and Communications of the Royal Academy of Sciences at Amsterdam," *Natural History* Section, Second Series, Part IV. (*Verslagen en Mededeelingen der Koninklijke Akademie van Wetenschappen, Afdeeling* Natuurkunde, 2de Reeks, Deel IV. Amsterdam, 1870), W. Koster brings forward some very interesting Anatomical Researches and Observations (*Ontleedkundige Onderzoekingen en Waarnemingen*). Of these the first is "*On the Artery of the inferior right Branchial Arch of the Embryo, recognisable in the Bronchial Arteries.*"

I. "It is generally supposed that, in the development of the human body, the artery of the inferior (fifth) branchial arch of the *right* side entirely disappears. I think I shall, on the contrary, be able to shew that in the bronchial arteries (particularly in the enlarged

right bronchial artery occasionally met with) the artery of the fifth right branchial arch of the embryo is recognisable; and that this theory is capable of explaining some peculiarities of the bronchial arteries, of clearing up some important vascular anomalies, and even of accounting for some morbid processes, the origin of which was heretofore obscure.

"To this view of the signification of the bronchial artery I was led by the examination of a case in which a large artery arose, posteriorly, from the arch of the aorta, gave off a small branch for the left lung, and afterwards ran in front of the inferior part of the trachea to pass along the right bronchus and for a short distance even above this bronchus, and so to reach the right lung. In addition there existed, as usual, smaller bronchial arteries. This observation was not new[1], but I had myself never seen such a highly developed right bronchial artery. In connexion with the study of the metamorphoses of the arteries of the branchial arches of the embryo, in which it had always struck me as remarkable that the right inferior vessel should in man so completely disappear, while in the amphibia it is of such great importance for the development of the pulmonary vascular system, and in some cases of 'abnormal development' remains open, the observation of this strongly developed right bronchial artery led me to the opinion I have already expressed."

It would occupy too much space to follow the author through the detailed exposition of his views, which he illustrates with two diagrams. He adds that:

"Only the knowledge of the anatomical peculiarities respecting the bronchial arteries, and of the abnormal forms of development presently to be considered, which from the nature of the thing are accurately studied by pathologists exclusively in the human body, could lead to the discovery of the remains of the artery of the right inferior branchial arch." He remarks upon the statements of von Baer and Rathke, who, unacquainted with the anthropotomic and anatomico-pathological peculiarities, make this vessel totally disappear in birds and mammalia. Rathke is absolute in his statement, von Baer on the contrary actually saw the pulmonary branches from the artery of the fifth right branchial arch, the existence of which the author, from anatomical and pathological observations, assumed. He refers to a case observed by Breschet and quoted by Dr Turner in the *Brit. and For. Med.-Chi. Rev.* xxx. 464, where in a newly-born infant "the inferior two arches remained open." He found that the left branch of the pulmonary artery passed to the left lung, while the right joined the right subclavian artery. Nothing particular is mentioned as to the bronchial arteries. The writer thinks he may infer from his observation that the right branches of the pulmonary artery proceed not from the left, but from the right fifth branchial

[1] This will appear, among others, from the description in Henle's *Handbuch*, III., Abtheil. I. p. 155, where we find the fact, so important for my subsequent investigation, that the artery even above the bronchus reaches the posterior wall of the latter.

arch. (He seems to think that the right branch of the pulmonary artery is always connected with the fourth right arch, but in normal cases disappears, but to forget that the branches for the right lung out of the fifth right arch are in connexion, not with the pulmonary artery, but with the aorta.) A better insight into this anomalous connexion between the pulmonary artery and the right subclavian, will appear to be possible from my view of the bronchial artery, as a remnant of the fifth right branchial arch.

"This view of the right bronchial artery moreover connects the development of the vascular system in the lower and higher vertebrate animals, and explains some facts in comparative anatomy.

"But of still greater importance appears to me to be the explanation which it is capable of giving of some vascular anomalies and 'morbid' conditious, proceeding from unusual development. I have already referred to the fact that Krause (in Henle's work above quoted), to explain some vascular anomalies, had to assume persistent patency of the fifth right arch. These anomalies are: 1. A large connecting branch between the right branch of the pulmonary artery and the arteria innominata. 2. The right subclavian artery is a branch of the pulmonary artery. 3. The right subclavian artery is a branch of the descending aorta. The first and second anomalies differ only in degree. In Krause's opinion they depend on persistent patency of the artery of the fifth right branchial arch." Krause does not attempt, however, to shew how these anomalies can occur in the manner referred to. "But if we start," adds Dr Koster, "from the fact, observed by me, that the artery of the right inferior branchial arch originally, just as in the amphibia, gave off pulmonary arteries, completely agreeing with those of the left side, it is possible to conceive of the singular origin of the right subclavian from the pulmonary artery." The author dwells at considerable length upon this point; to follow him would, however, lead us beyond the limits assigned to these notices.

"To the connexion between the right subclavian artery of abnormal origin and the artery of the right inferior branchial arch is related another group of anomalies, which seem first to receive their complete explanation from my view of the right bronchial artery, namely, *the origin of great pulmonary branches from the descending aorta.*"

Having quoted the principal cases of this abnormity from Meckel's *Handbuch der path. Anat.* II^ter^ Th. and Meckel's *Archiv für die Physiologie*, Bnd II. und VI., and explained them in accordance with his own views, Dr Koster continues:

"It is evident that my theory of the existence of traces of the right aorta, in many instances, in the human body, with the insight which it may give in some anatomical peculiarities, is important specially as relating to the morphology of vertebrate animals, and that it is of only moderate interest to the physician. * * * * In some cases, however, abnormal forms of development of the heart and great vessels occur, which have not, until a later period of life, an injurious influence upon the vital functions, giving rise to actual

diseases, chiefly hypertrophies of the heart, with impaired pulmonary circulation, dropsy in the chest or elsewhere, &c. During life we shall indeed seldom succeed in tracing the connexion between these diseases and abnormal development of the right fifth arch; but even in the examination of the body one could not, without accurate anatomical and embryogenetical knowledge, understand the origin of some of the 'diseases of the heart' here referred to. A remarkable example of this is to be found in a 'Case of abnormal Communication of the Aorta with the Pulmonary Artery,' by Dr O. Fraeutzel, of Berlin, published in *Virchow's Archiv*, XLIII. 420." Dr Koster concludes his valuable communication with a detailed application of his views to this interesting case.

II. The author next describes a case of *division of the inferior part of the omohyoid muscle*. Having referred to the numerous deviations of this muscle from the normal condition he continues: "To the rarer reduplications of the muscle described by Kelch and Gubler belongs the peculiarity observed by me last year, on the left[1] side of the neck of a moderately muscular subject of about thirty years. On the other side the muscle was normal, with the exception of deficiency of the middle tendon. The reduplication of the inferior part of the muscle, in my case, seems to deserve to be briefly recorded, not only as a form hitherto not discussed, but also because it shews that the complete reduplication with abnormal points of origin, observed in other cases, may occur actually by splitting of the omohyoid itself, and that it is not merely apparent, a new muscle having arisen next to the omohyoid." The muscle described by the author arises in the usual manner from the transverse ligament and upper edge of the scapula, runs at first undivided, then splits into two parts, of which the posterior proceeds in the ordinary manner to the os hyoides, while the anterior coalesces with the sterno-hyoid muscle. The author reviews the several degrees of this abnormity observed from time to time, and concludes with remarking that, "My observation finally confirms the embryogenetic signification of the muscles between the os hyoides, the scapula and the sternum as intercostal muscles (superior belly of the omohyoid, the sternohyoid and the sternothyroid) and the musculus serratus anticus major (inferior belly of the omohyoid muscle). If we consider the upper part of the muscle in my case, from above, and if it be proved that in the middle of the muscle (in the tendon) the analogue of a rib is found, while in the course of the sternohyoid muscle ribs may virtually be assumed, the very outward appearance of the part actually recalls the dentated origin of the musculus serratus anticus major."

III. The author describes an *unusual course of the Phrenic Nerve of the right side*. When the subclavian artery and the brachial plexus were exposed, a tolerably thick nerve was seen to run from above with the supraclavicular nerves, and apparently belonging to these, but which more inferiorly, above the clavicle, continued behind

[1] There is evidently a mistake in the text: in the plate which illustrates the case, the abnormity is represented as being on the *right* side. W. D. M.

the omohyoid muscle, again sank deeply, and disappeared behind the clavicle.

It proved tó be the phrenic nerve which, with the other nerves of the cervical plexus, and along the brachial plexus, ran obliquely outwards, in place of at once passing inwards over the anterior surface of the musculus scalenus anticus, and of then running between the subclavian artery and vein, close to the internal mammary artery, to reach the cavity of the chest. The nerve, in this unusual case, reached the upper opening of the chest by, after having described the above-mentioned curve outwards, behind the arteria transversa colli and transversa scapulæ, and consequently *in front of the subclavian vein,* passing strongly curved inwards behind the first rib and in front of the internal mammary artery (that is, betweeen this vessel and the wall of the thorax). Afterwards the nerve regained its usual situation, close to the superior vena cava, and passed between the pleura and the pericardium, in the ordinary manner, down to the diaphragm.

The extensive investigations of Luschka (*Der nervus phrenicus des Menschen,* 1853, p. 14) enabled the author to explain the unusual course of the whole nerve in his case. "It arose, for by far the greater part, united with the supraclavicular nerves, from the fourth cervical nerve, but also received higher up a filament from the cervical plexus. I have not noted anything respecting a root lower down from the fifth cervical nerve. The nerve therefore arose high up, and then the whole mass of fasciculi separated later than usual from the supraclavicular nerves to unite subsequently with the radical filament, which already, so to speak, inclines outward and more to the surface in front of *the subclavian vein,* sometimes even as nervus phrenicus secundarius. In the cases of normal course, the previously independent innermost and greatest division takes with it, as it were, the radical filament arising higher up. The other peculiarities, that the nerve passed in front of the mammary artery, was further removed from the right vena innominata, and later than ordinarily reached the superior vena cava, follow necessarily from the unusual course of the nerve. Of the ordinary phrenic nerve, in front of the scalenus muscle, no trace was found."

INDEX TO VOLUME IV.

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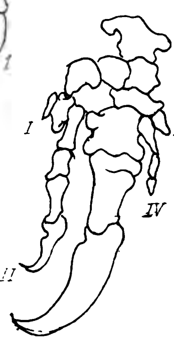

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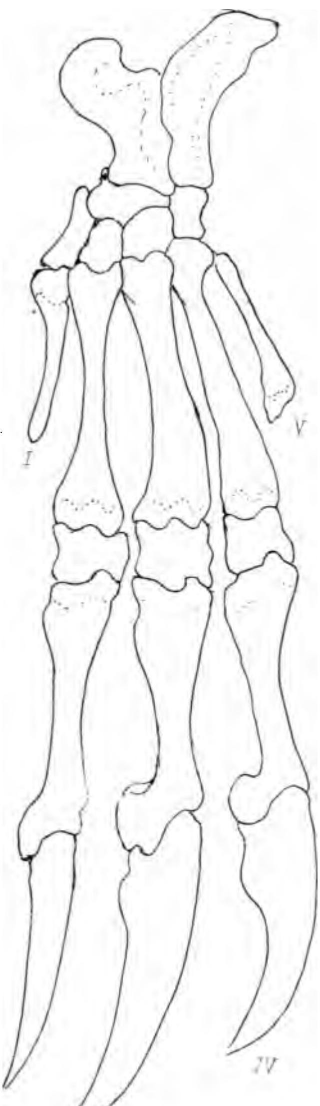

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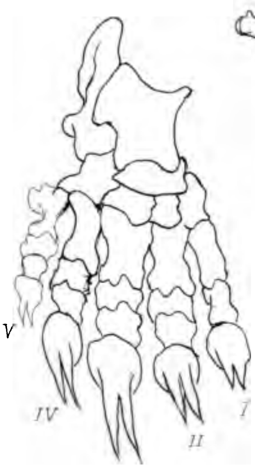

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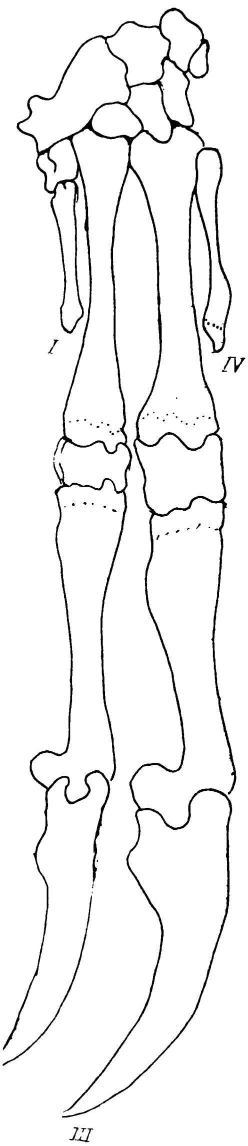

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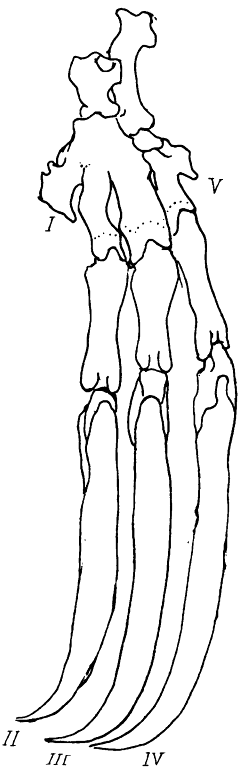

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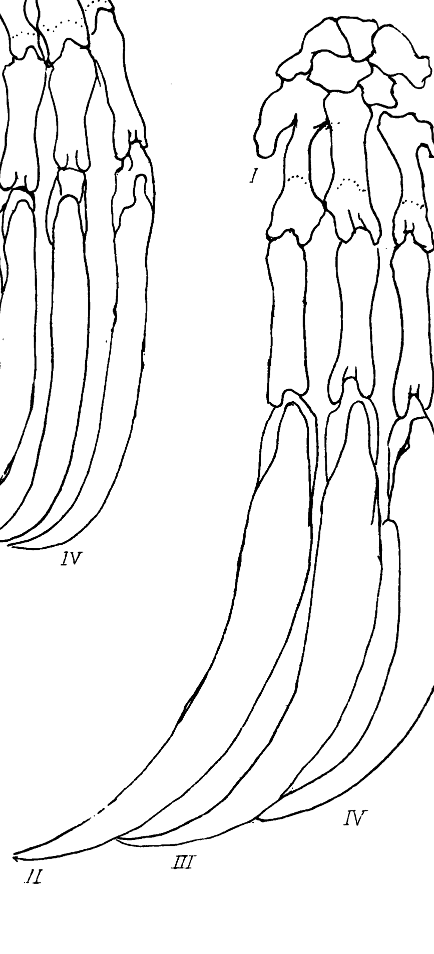

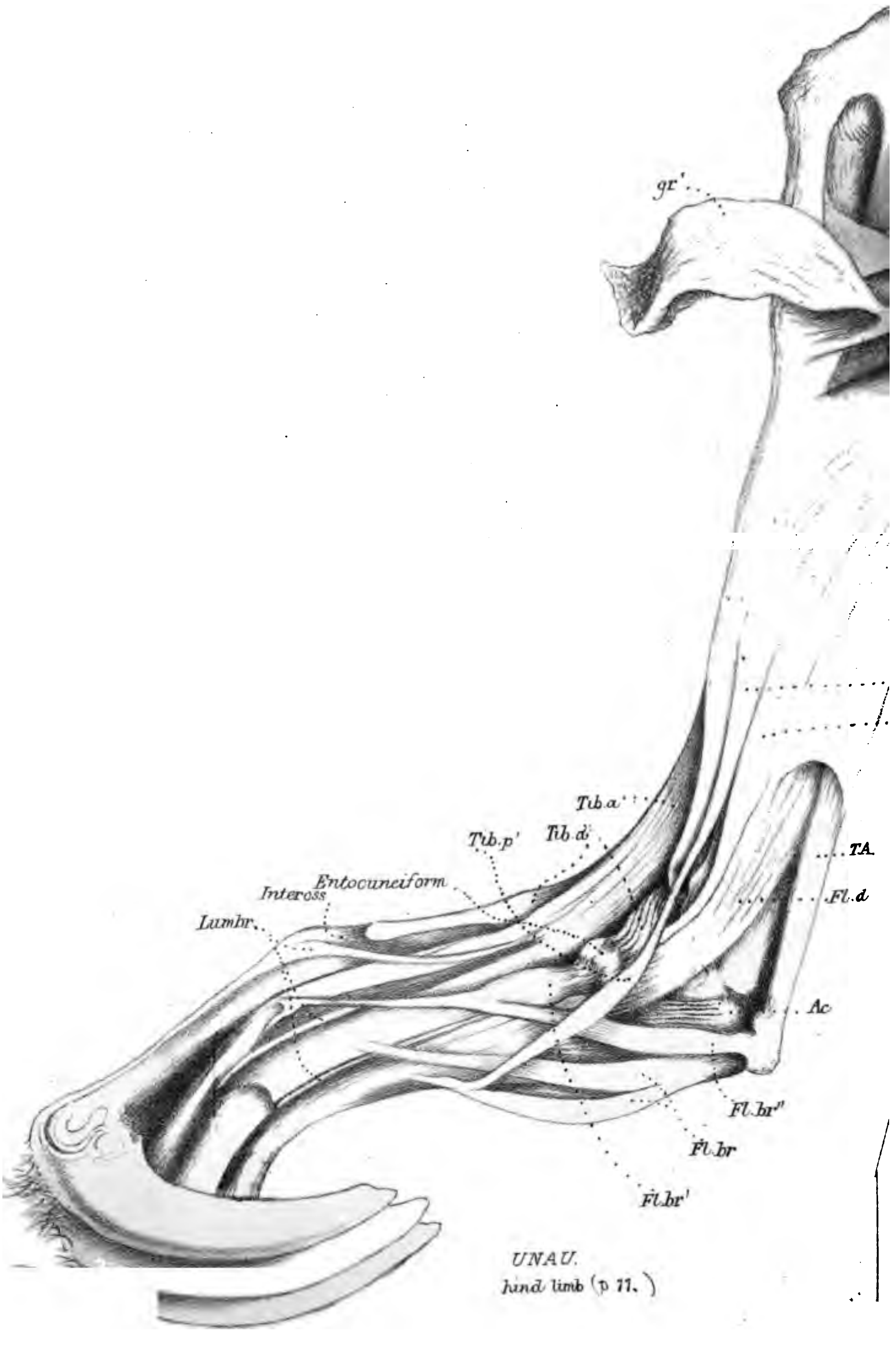

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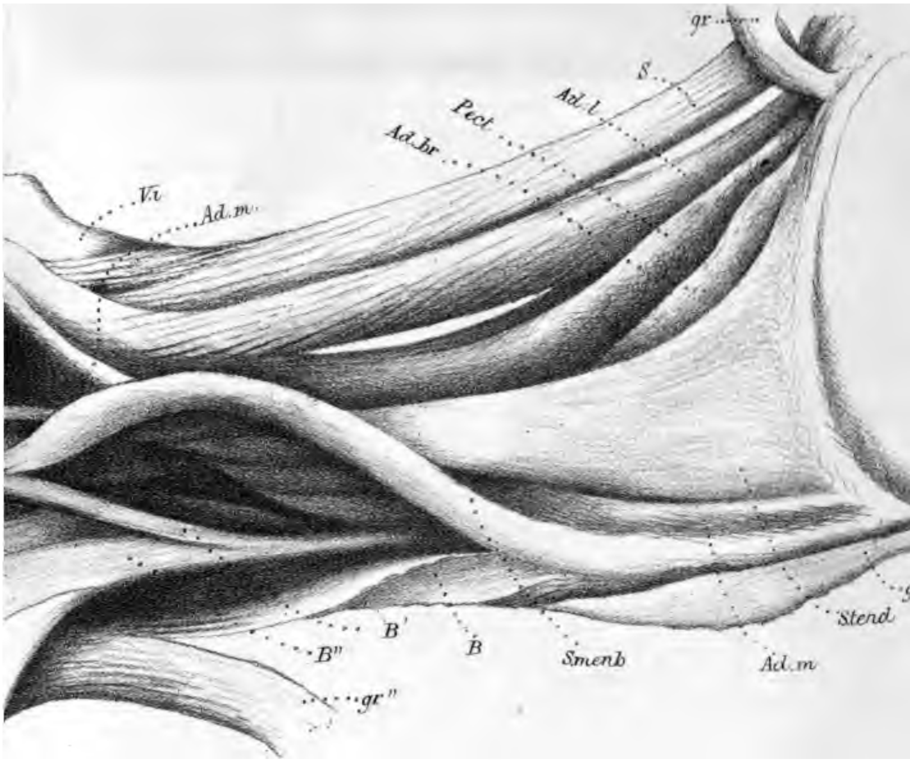

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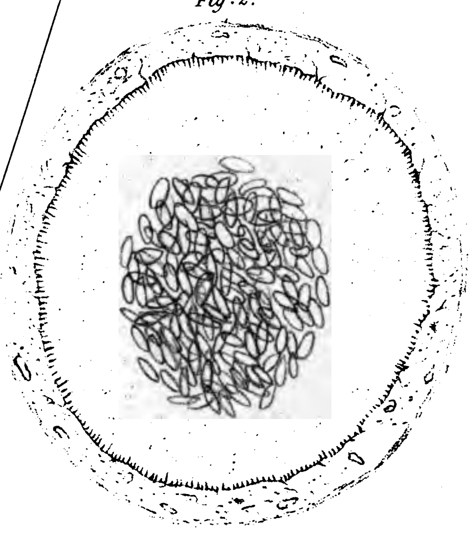

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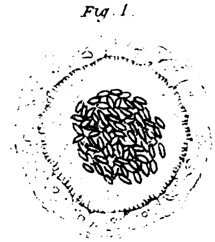

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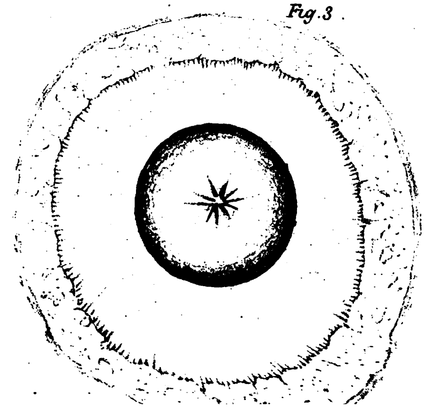

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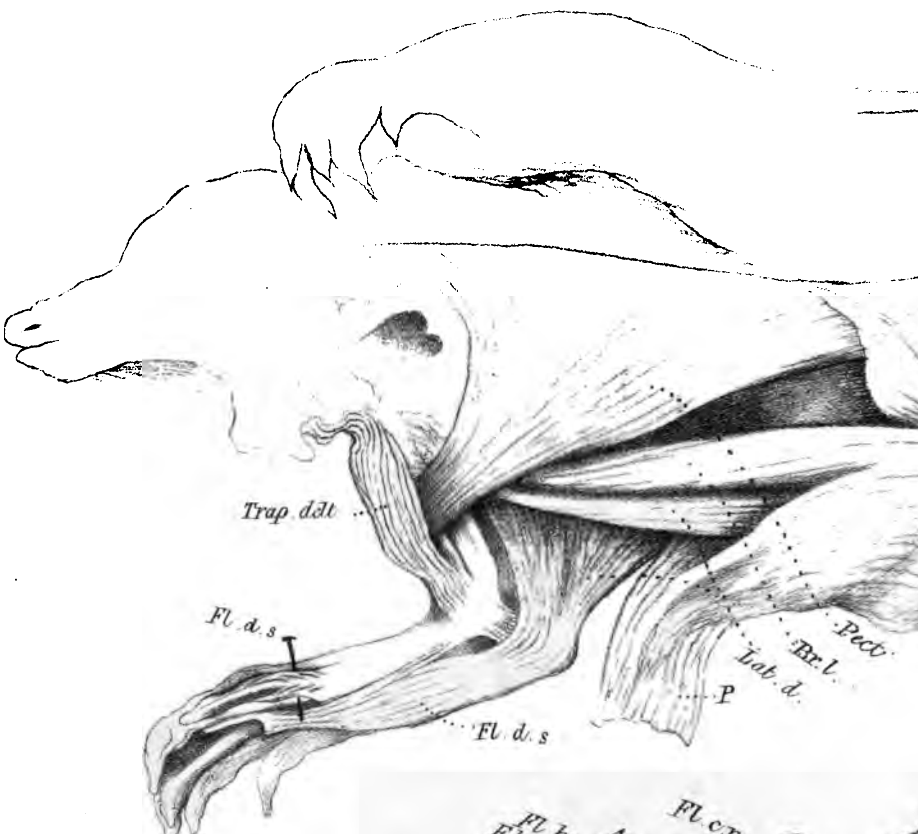
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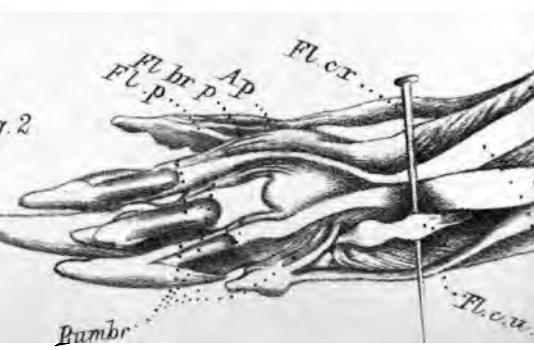
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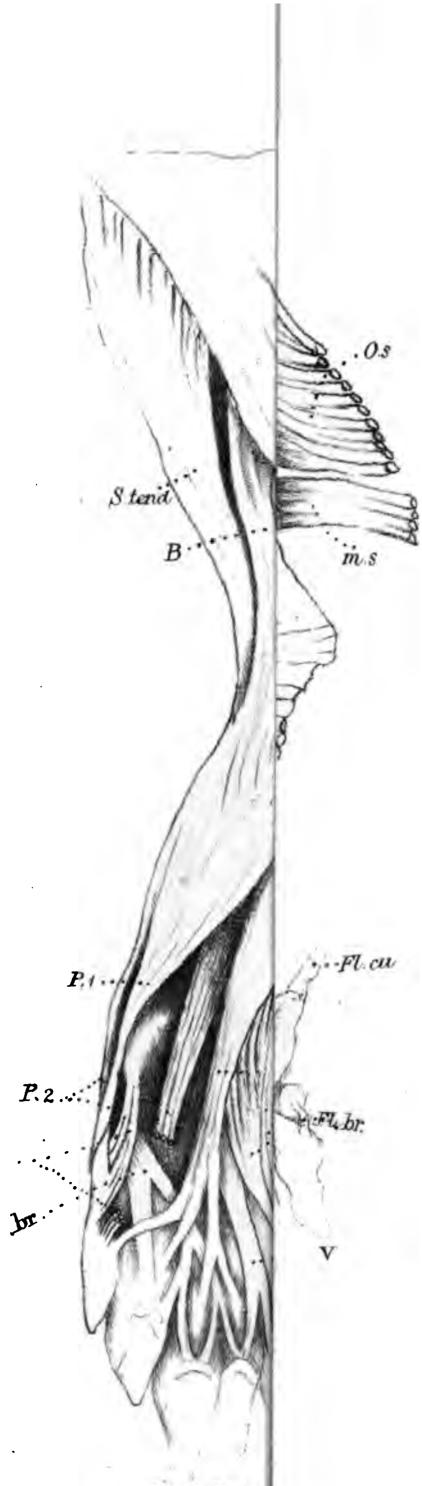

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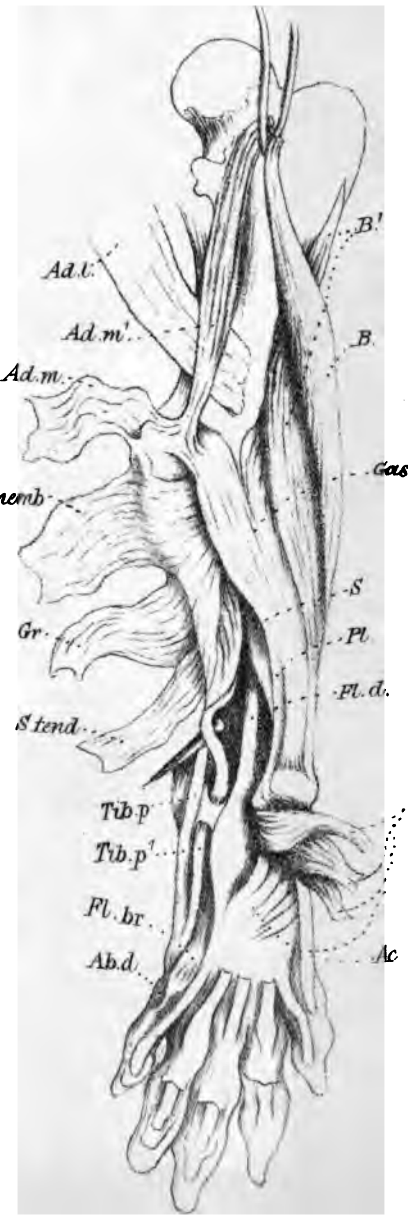

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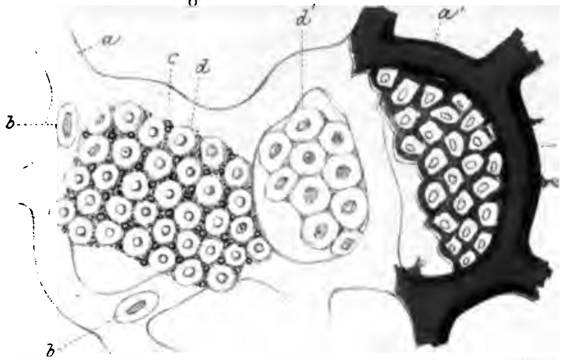

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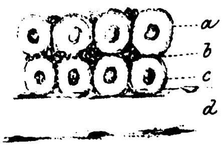

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Diaplasmatic Vessels.

T. A. Carter, del.[t]

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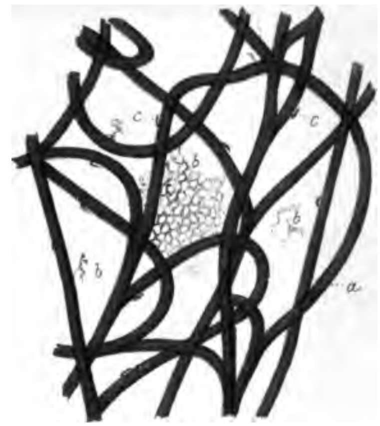

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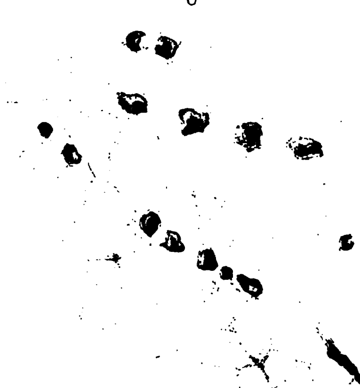
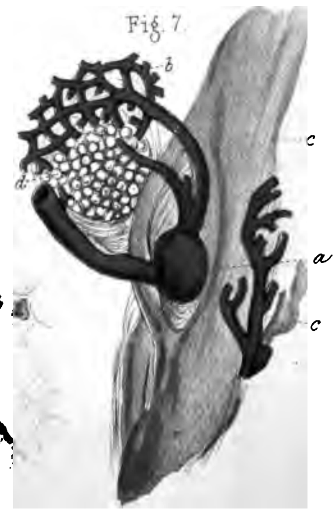
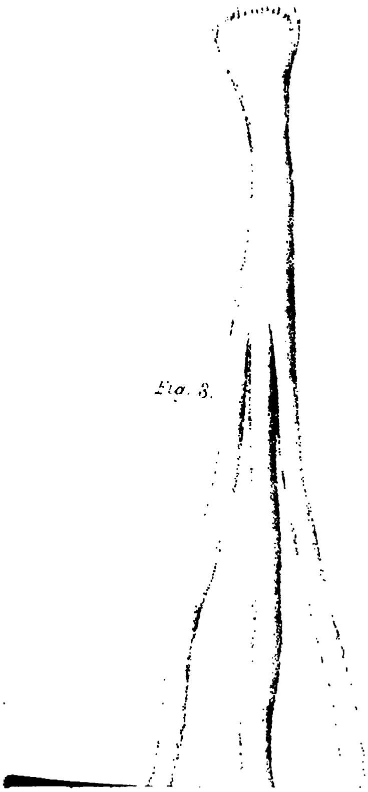




Diaplasmatic Vessels.

T. A. Carter, del.t W. H. McFarlane, Lith.r



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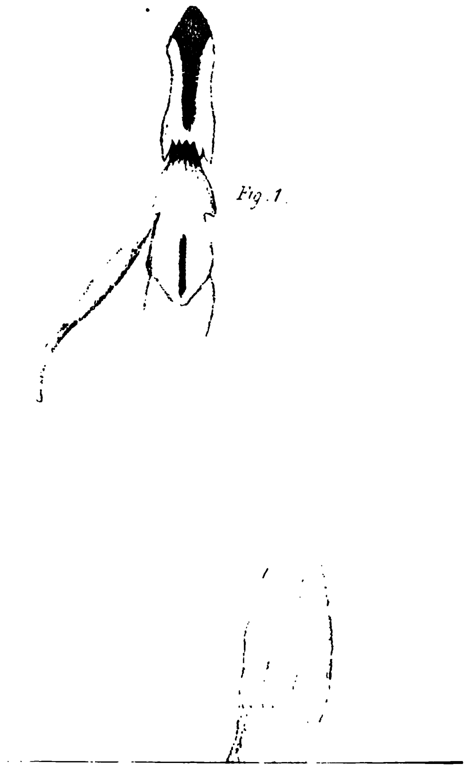

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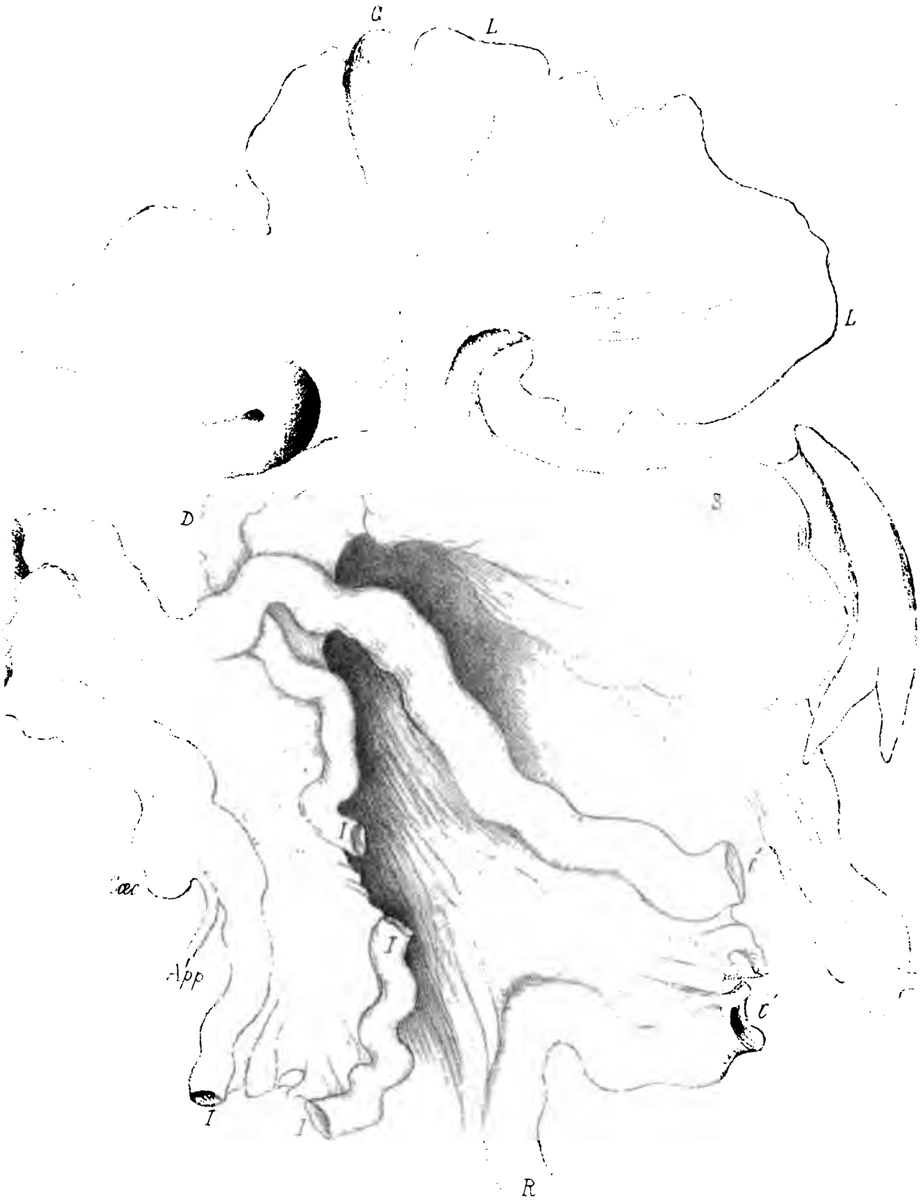

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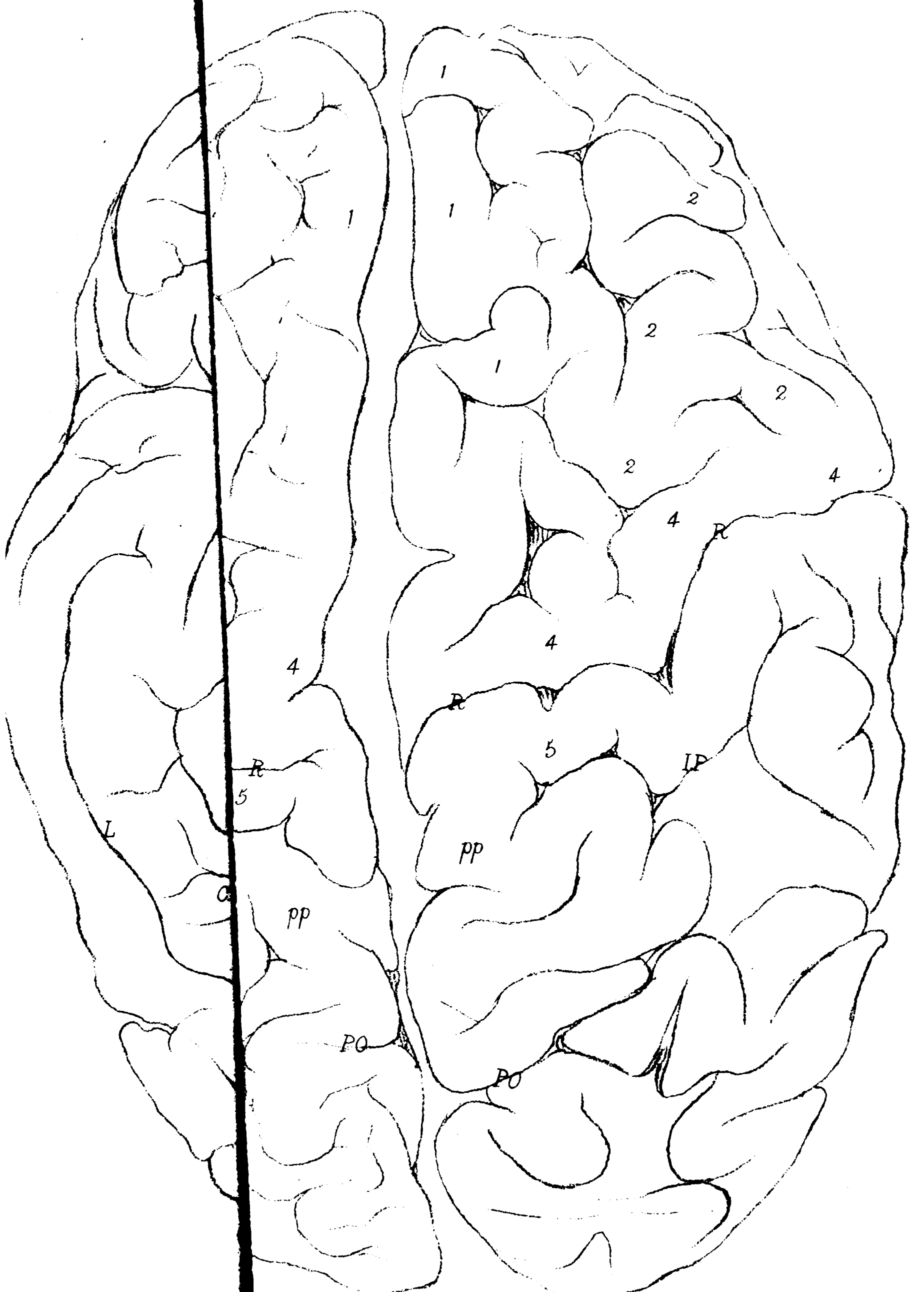
LIVER, STOMACH & INTESTINES OF WOMBAT.

Pl IX



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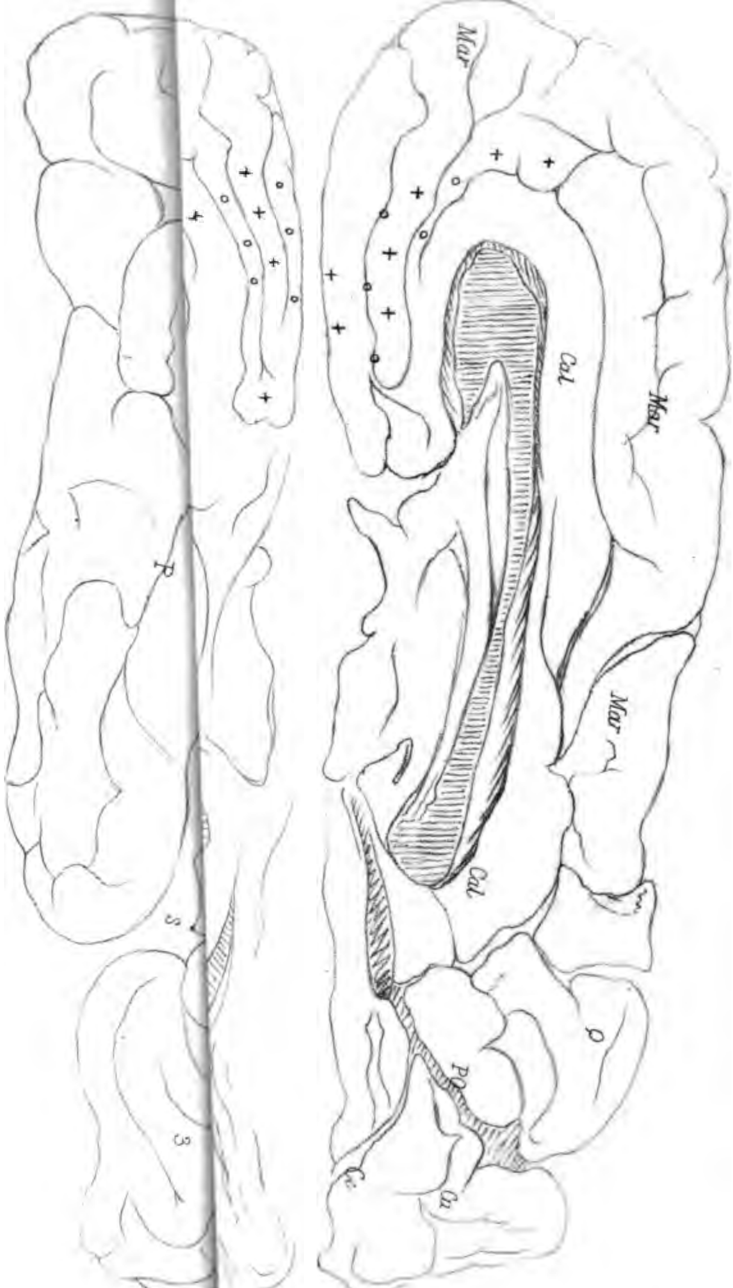

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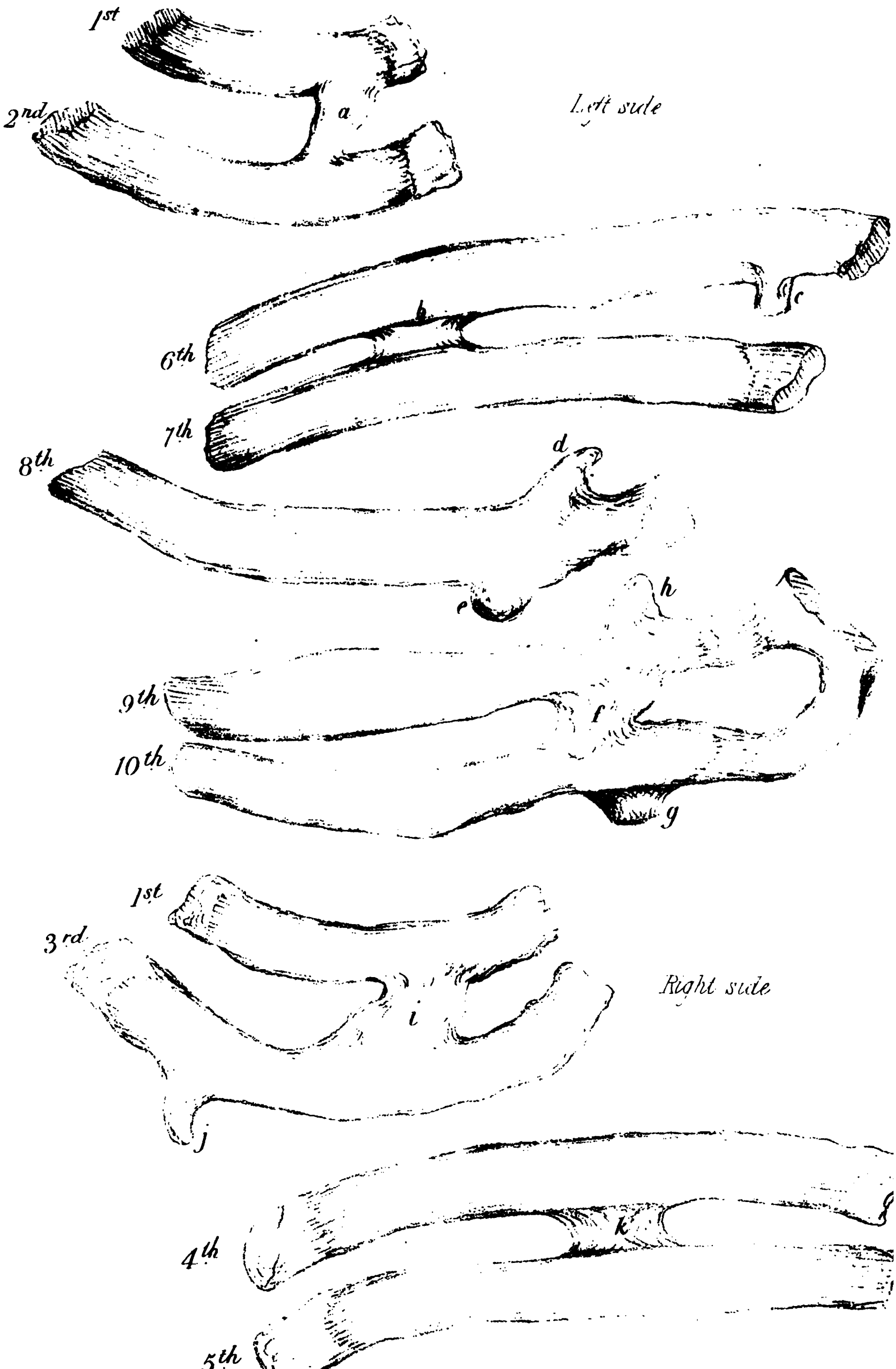

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